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CR 82.018

NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

Sponsored by
NAVAL FACILITIES ENGINEERING COMMAND

SEADYN: PROGRAMMER'S REFERENCE MANUAL

April 1982

An Investigation Conducted by
Dr. R. L. Webster
Consulting Engineer
Brigham City, Utah

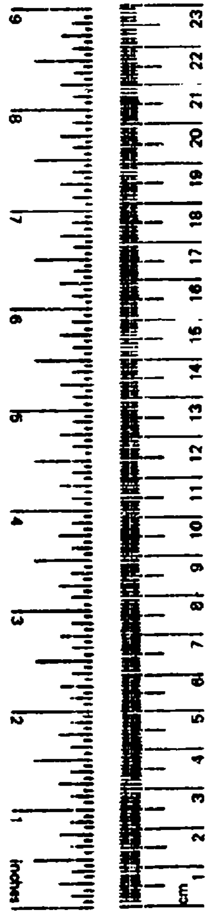
N62474-81-C-9391

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

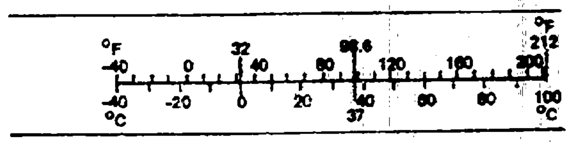
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE — READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: CR 82.018	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): SEADYN: Programmer's Reference Manual	5. TYPE OF REPORT & PERIOD COVERED: Final Oct 1977 - Sep 1981
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Dr. R. L. Webster	8. CONTRACT OR GRANT NUMBER(s): N62474-81-C-9391
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Dr. R. L. Webster, Consulting Engineer, Brigham City, Utah 84302	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62759N: YF59.556.091.01.402
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE: April 1982
	13. NUMBER OF PAGES: 87
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS (of this report): Unclassified
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cable dynamics; SEADYN computer model; SEADYN software

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The internal workings of the SEADYN cable, truss, and mooring program are detailed. Descriptions are given of the overall program structure and logic. Storage features, such as COMMON, data files, and variable dimensioning are discussed. Descriptions are given for each of the subroutines and the major variables used. The information provided is intended to

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augment the general description of the program provided in the User's Manual and Mathematical Models and provide a programmer with assistance in understanding the internal workings of the SEADYN programming. Instructions for converting the program to various machines and for modifying the program are also provided.

TABLE OF CONTENTS

1.0 INTRODUCTION

The SEADYN computer program is a multifunctional tool for analyzing the structural response of cable, truss, and mooring systems. The purpose of this manual is to document some of the major aspects of the program structure. Program documentation also includes a theoretical manual (Ref 1) and a user's manual (Ref 2). The information contained in this manual is intended for a computer programmer and the more sophisticated user who may find it necessary to get involved with the internal workings of the program.

The SEADYN program traces its pedigree from some early work done by Leonard (Ref 3) through a study project carried out by the Bechtel Corporation for the Electronic Systems Division of the General Electric Company (GE). The end product of that work was a program called NLIN (Ref 4). This author was technical advisor on that project. The SEADYN program began where NLIN left off as part of the author's doctoral project in 1974. It has been under various levels of development since then with sponsorship coming from GE, the Chesapeake Division of the Naval Facilities Engineering Command (CHESDIV), and finally the Naval Civil Engineering Laboratory (NCEL). The support of CHESDIV led to the implementation of the ship mooring capabilities for static and frequency domain solutions in 1976. NCEL support has provided for the pay-out/reel-in capability, the drag amplification calculations for strumming, the viscous relaxation static solution, the bottom limited catenary element, various revisions and improvements in the solution algorithms, and a complete restructuring of the program including the new free-field input format.

A plotting post-processor program which is based on the restart file structure described in this document is also available [5].

2.0 PROGRAM STRUCTURE

THE SEADYN program is composed of a simple main program, which establishes the size of the working storage in COMMON/ACOM/ and numerous subroutines. The heart of the program is found in the SEADYN and MANIPR subroutines. SEADYN is called by the main program and manages the setup of storage partitioning, reading, and deciphering of the free-field input and the initial access to the restart files. Control is then passed to the MANIPR subroutine to manage the actual problem solution through calls to the subanalysis routines.

The programming effort has attempted to maintain modularity in the structure. Major subanalyses are handled in separate groups of subroutines that are called in response to input requests. The overall analysis and the individual solution options have been written to be nearly independent of the type of element used to generate the equations. For example, the element stiffnesses and internal force components are generated from calls to a single controlling routine regardless of the type of analysis being performed. This modularity should prove to be useful if the addition of new subanalyses, solution options, or element types are contemplated.

The program is written entirely in FORTRAN IV (CDC-Extended FORTRAN). Initial developments were on a GE-635 computer with compatibility with a CDC-6600 computer maintained. Since 1977, development has been on a CDC-7600. Some effort has been directed at restructuring to facilitate conversion to ANSI standard FORTRAN-77 and to other machines. Conversions of interim versions have been accomplished on the VAX11/780, PRIME, and DATA GENERAL machines. The major items encountered in conversion include:

1. The free-field reader -- uses ENCODE/DECODE
uses R-FORMAT character manipulations
2. The CDC-program statement in the main program
3. End of file checks using IF(EOF) a,b
4. The use of character strings in titles, date and time (including Hollerith word lengths)
5. Asterisk (*) comment cards
6. Asterisk (*) and quote (") format delimitors
7. The need for double precision on 32-bit word machines
8. Seven character subroutine name: RESTART

The global logic structure is represented in Figure 2.1. The relationships of the major subroutines are outlined in Figure 2.2.

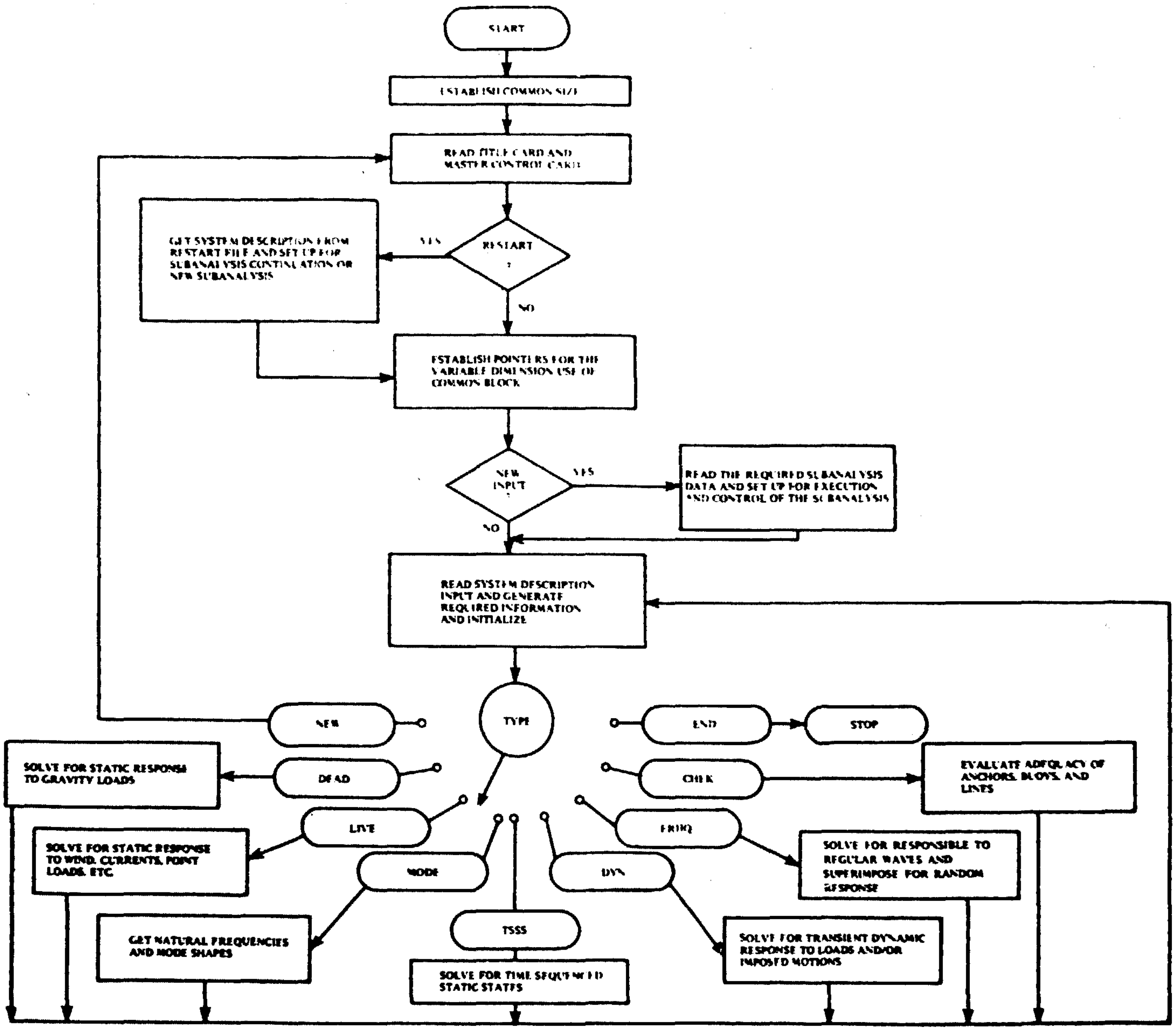
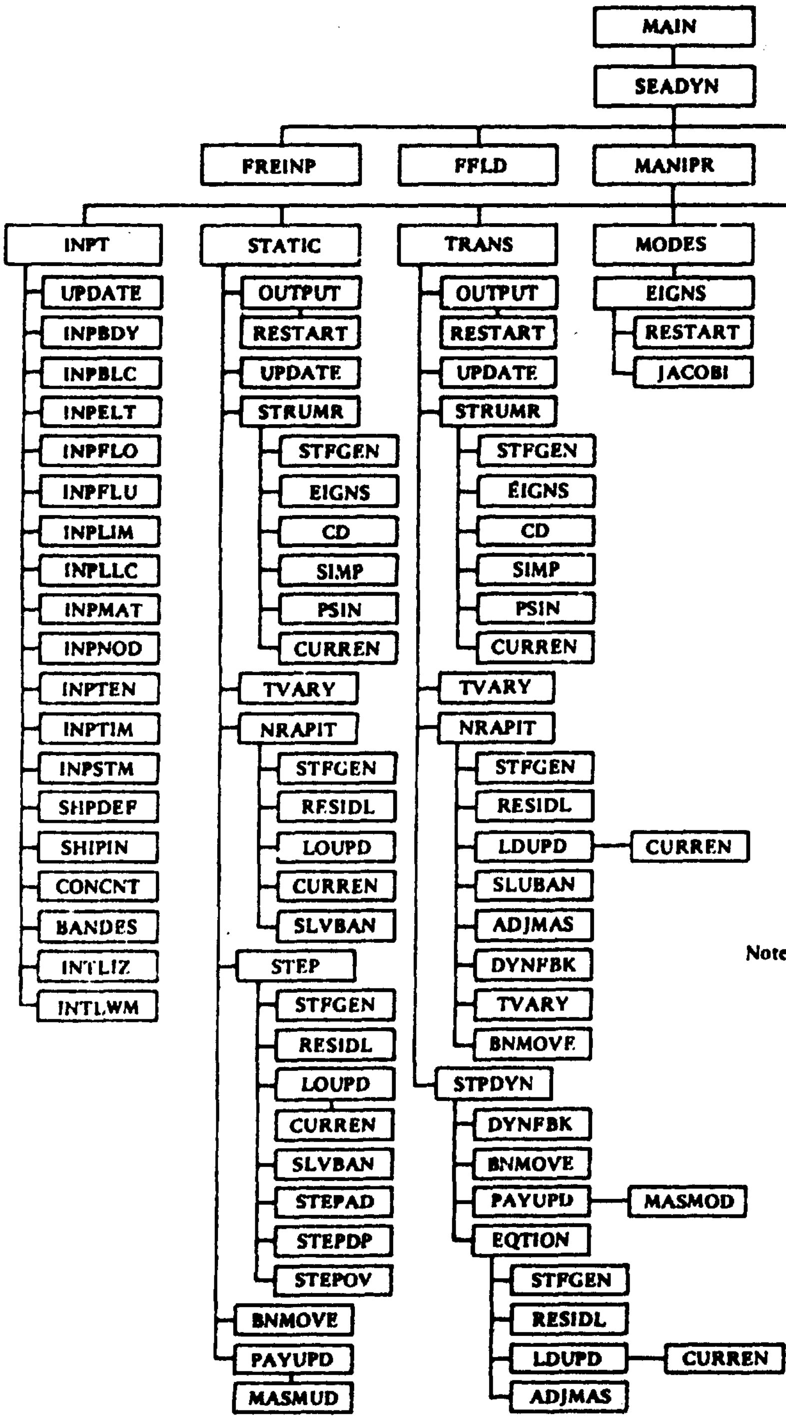


Figure 2.1. Macro flow chart for SEADYN.



Note: Three user written subroutines are available -
DRAGCO called by LOUPD
CURUSR called by CURREN
TFNUSR called by TVARY

Figure 2.2 Outline of major subroutine relationships.

3.0 DESCRIPTIONS OF COMMON STORAGE

Common storage can be segregated into four categories: working area for variable dimension data, fixed length storage for restart data, scratch storage for communication between subroutines, and special data tables. Each of these are described below.

3.1 Working Storage for Variable Dimension Data

COMMON/ACOM/ A(XXXXX)

The length of the A array is specified in the MAIN program. Partitioning of A into the data arrays needed in the solution is done by the SEADYN and MANIPR subroutines. SEADYN reads the problem description data or restart file to determine the size of the data arrays. SEADYN then passes the first position of each array to MANIPR through its calling sequence. With only two exceptions, /ACOM/ is referred to only indirectly through the subroutine calling sequences. The two exceptions are the MODES and FREQ subanalyses which place the contents of /ACOM/ on a scratch file using RESTART and then use the storage for other purposes. /ACOM/ is restored through RESTART upon exit from these subanalyses. The partitioning of /ACOM/ is described in Table 3.1.

3.2 Fixed Length Storage for Restart Data

In addition to the element and node data contained in /ACOM/, the essential problem data are contained in a set of common blocks with fixed dimensions. These are arranged in pairs which contain floating point and fixed point data in segregated forms. A separate common block contains all of the logical variables. These blocks are written and read for restart purposes. The segregation is made to facilitate the conversion to machines which use byte-oriented storage with type-dependent word structures.

The use of the common blocks is summarized below. The actual structure of the common blocks is given in Table 3.2.

/BUOYS/, /IBUOYS/	Body tables, limit set data, body and limit location data, surface buoy data and related control data
/CABLE/, /ICABLE/	Line element data and material tables, fluid data
/CONTRL/, /ICNTRL/	Basic control information for the solution options
/DSPCON/, /IDSPCN/	Static imposed displacement data and norm data for static iterative solutions
/PAYOUT/, /IPAYOT/	Pay-out/reel-in data
/SHIPS/, /ISHIPS/	Data for ships and static ship loads
/STRUM/, /ISTRUM/	Strum string data
/TIMED/, /ITIMED/	Transient response data
/LOGIC/	Logical variables used for solution control

Table 3.1. /ACOM/ Useage in SEADYN

Base Definition Through MANIPR			Secondary Use in FREQ SAO		Secondary Use in MODE SAO	
Variable Name	NC_i	Size	Variable Name	Size	Variable Name	Size
A	1	NE			GMM	NF3
DS	2				GKK	½(NF3)(NF3+1)
DSO	3				TGK	NF3,NF3
DSR	4				EIGEN	NF3
ES	5					
ET	6					
GMA	7					
IT	8	2,NE				
DOMP	9	NE				
MAT	10					
SIG	11					
SIGR	12					
STN	13					
TR	14	3,NE				
THR	15	3,NE	CTEN	COMPLEX(NE)		
TRNSTR	16	3,3,NE				
MEDIUM	NCMP	NE				
DRGAMP	NSTM	NE				
XC	17	NN3				
XO	18					
NODFIX	19					
DU	20		FZ	COMPLEX(NF3)		
F	21					
FG	22		UZ	COMPLEX(NF3)		
FP	23	3,NN3				
F1	24	NN3	Z	COMPLEX(NF3,IBEND)		
F2	25					
GM	26					
U	27					
UD	28					
UDD	29					
UP	30					
UDP	31					
UDDP	32					
US	33					
UDDS	34					
VF	35					
VW	36					
GK	37	NF3,IBEND	GK	NF3,IBEND moved into Z		
			CGM	NF3,IBEND		

Notes: NE = no. of elements.
NN3 = 3 times no. of nodes.
NF3 = 3 times (no. of nodes - no. of slave nodes).
IBEND = half bandwidth.
NC_i = refers to the position parameters computed by SEADYN.

Table 3.2. Fixed Length Restart Common Blocks

```
 COMMON/BUOYS/
1 AABUOY(100),ADM(50),BAMC(50),BLEN(50),BMOM(50),BOMAS(50),
2 BOVOL(50),BSCD(50),BUOKP(3,50),BWND(50),CBUO,CORDLM(50),
3 CYLRMS(50),DBU(50),FBUSR(50),RELFAC(50),SBAMP(50),SGNDLD,
4 TOLIM(50),UBS(50),VIB(3)

 COMMON/IBUOYS/ IAABU(10),
1 IBS(50),IBU(50),IDRB(50),IMPBOD,IMPNOD,IOPT,JANCR(50),
2 JSLP(2,50),KNSTRN,KONECT(10,50),LBODN(50),LIMNOD(50),
3 LIMSET(50),MBLN(50),MEDMB(50),MORBUO,MXBLOC,MXBODY,
4 MXLIMS,MXLLOC,NBLOC,NBUTAB,NCYLB,NLIMS,NLLOC,NMOTN(50)

 COMMON/CABLE/
1 AACAB(100),CABMAS(10),CAMC(10),CURMUL,DIAM(10),E(20,10),
2 FDEPTH(5),FGAM(5),FLPAR(10,10),FVISC(5),G3(10),STR(20,10),
3 TENULT(10),TT(20,10),TTD(10),TTK(10)

 COMMON/ICABLE/ IAACA(10),
1 IDAMPR,IDRG(10),IFLCOD(10),MATDMP(10),MATT,ME(10),MED(10),
2 MXFLOW,NFLUI,NFLVRY

 COMMON/CONTRL/
. AACON(100),ACCFAC,DELFAC,DERAD,DELTMP,DERR,DMU,
1 EXTRAP,FDIVY,FINC,FLNVY,FRCVY,GRAV,G1,G2,OVRSHT,
2 PARMT,PI,PINC,PSTEP,RATD,RERR,SRCHFC,SSTART

 COMMON/ICNTRL/ IAACL(10),
3 IBEND,IBEND1,IBEND2,IBG,IDIR,IFCNT,IFXFL,IGK,IKNSTN,INC,
4 INDRAG,INVY,IPR,ISTART,IUPDT,JDLD,JDYN,JMPDT,JOVR,
5 KONVRT,KOUNT,KUP,LMITER,MOSTAT,MVB,MVBINC,NBASE,NCONC,
6 NE,NFN,NF3,NFLUID,NFIX,NN,NN3,NPRST,NRUP,NSLAVE,
7 NSTUP,NTYPE,NUMSET,NUP,NXTYPE,MODEI1,MODEI2

 COMMON/DSPCON/
1 AADSP(100),DISPC(30),DISPP(30),HIRSDL,RNORM,RNORMP,RNRMPP,
2 VNORMP,VNPP,VNPPP

 COMMON/IDSPCN/ IAADS(10),
1 IDIS(30,3),IDWN,TNUP,ITUP,JSTEPR,LMKEEP,NDISP,NDROP,
2 NFKEEP(30),NODWN,NSLOP

 COMMON/PAYOUT/
1 AAPAY(100),AMAXL(5),CURLEN(5),DELT,DLREF(5),DPTMF(5),
2 ESP(2,5),PAYV(5),PTMF(5),TFSAV(5),UMVB(15,3),UMVBP(15,3)

 COMMON/IPAYOT/ IAAPO(10),
1 JOP(5),JPELT(5),MITNOT,MULMAT(5),MULTIM,NELPOI(5),NGROW(5),
2 NNPOI(5),NOP,NPOVRY(5),NSHRNK(5)
```

Table 3.2. (Continued)

```
      COMMON/SHIPS/
     1 AASHP(100),ACCCUR,ACCWND,APROP(3),BLOCK(3),CAD,CPROP(3),
     2 CR(3),CS(3),CURCOE(20,3,5),CURHED(20),CURNT,CURVEL(5),DRAD,
     3 FACH(3),FSFRC(3),FSFRW(3),FSLEN(3),FSVEL(3),GAIR,HEAD(3),
     4 HEDEND,HEDIMX,HEDINC,HEDNOW,PROPF(3),RATL(3),SAE(3),SAS(3),
     5 SBEAM(3),SDRFT(3),SDSPV(3),SFACW(3,3),SHIPK(4,3),SHPKP(3,3),
     6 SHTRN(3,3,3),SLT(3),SLWL(3),SURFCE,TSAPL(3),VAIR,WAD,WDEPTH(3),
     7 WIND,WNDCOE(20,3,5),WNDHED(20),WNDVEL(5)

      COMMON/ISHIPS/ IAASHP(10),
     1 ICR,IFREQ,ISHIP(3),ISHTAP,ISURLD,IUP,KODEC(2),KODEW(2),
     2 LSHP(3),MXSHIP,NCRNT,NSFILE,NSHIPS,NTHETC,NTHETW,NUMHED,NWIND

      COMMON/STRUM/
     1 AASTM(100,CEPS,CRST(30),GKS(3,3),QST(20),RVELN,RVELNP,
     2 STLEN(20)

      COMMON/ISTRUM/ IAASTM(10),
     1 ISTRNG(30),ISTRUP,KSTRNG(20,30),MXSELT,MXSTRG,NSTRNG,NSTRUP

      COMMON/TIMED/
     1 AATIM(100),ALPNEW,BETNEW,DALPHA,DBETA,DMAXAB,DMAXP,
     2 DT,DTH,DTL,DTLL,DTMAX,DTRSRT,DTU,ERR,FTF(3),FTI(15),GAMNEW,
     3 T,TMAX,TMFRF(3),TMFRM(15),TPARM(20,20),TRSRT,TZ,UB(15)

      COMMON/ITIMED/ IAATIM(10),
     1 IALTR,IB(5),ILF(3),IMTMF(15),IMX,ISIGN1,ISIGN2,ITFCOD(20),
     2 ITOP,JB(15),KNTRST,MXTFUN,NIXPRN
```

3.3 Scratch Storage Common Blocks

Temporary data or data not required by restart are handled in the following common blocks. Table 3.3 lists the contents.

/CDCAL/	Temporary data for strum string calculations
/CHKDAT/	Component check data for element fluid loads
/FRQDAT/	Frequency domain interface data
/HEDCHR/	Titles and labels for page headings
/HEDDAT/	Control data for page headings and working storage for free-field input processing
/RETAPE/	Restart file data
/SHPLBL/	Contains the ship load title block and labels for the ship load data set in current use
/SHPTAP/	Contains the ship dimension data for the ship load data set in current use

3.4 Common Blocks for Data Tables

Special purpose data tables are contained in the following common blocks. Table 3.4 lists the contents.

/COMPNT/	Component inventory tables
/SIZE/	List of common sizes
/TAPES/	List of file names
/TYPES/	List of numeric codes for input keywords
/IFLAG/	Array of input keywords

The mooring component inventories are contained in arrays which are generated by data statements in the COMPDT Subroutine. An explanation of the entries in the component inventory common block, /COMPNT/, is given below.

VARIABLE	DESCRIPTION
ATYPE	Label for each of 6 anchor types. Each label is three 6-character Hollerith words.
ANCTAB	Storage for anchor data for up to six anchor types (third dimension). The array allows up to 16 anchors of each type, listed in order of increasing weight. Five items are given for each anchor.

Word	Contents
1	Anchor weight
2-4	Hollerith labels for federal stock number
5	Holding power

The holding power is calculated from the weight and the factors given in HLDFAC.

NANCR — An array listing the number of anchors of each type in the inventory.

BTYPE — Label for each of two buoy types. Each label is three 6-character Hollerith words.

BUOTAB — Storage for buoy data for up to two buoy types. The array allows up to six buoys of each type, listed in order of increasing buoyancy. Seven items are given for each buoy:

Word	Contents
1	Outside diameter
2	Height
3	Weight
4	Nominal buoyancy
5	Maximum buoyancy
6-7	Hollerith label for federal stock number

NBUOY — An array listing the number of buoys of each type in the inventory.

HTYPE — Label for each of four hawser types. Each label is three 6-character Hollerith words.

HAWTAB — Storage for hawser data for up to four haswer types. The array allows up to 23 sizes for each type. The two entries for each size are the tensile strength and the weight per 100 units of length.

HAWSIZ — A list of the haswer sizes given in increasing order. It is assumed that all four hawser types have the same list of sizes. If no entry is available for a given size, then set the strength to zero and the weight to some small, nonzero number.

NHAWS — The number of howser sizes for each howser type. (Set to 23 for each hawser type.)

CHAIN — Storage array for chain data. Presumes only one chain type (stud-link chain). The array contains 31 entries for size, strength, and weight per unit length.

NCHN — The number of chain entries (31).

HLDFAC — A list of the holding power factors for the six anchor types. This is the number which multiplies the anchor weight to get the holding power in firm sand.

The component data presently listed in the inventories assume weights, buoyancies, and strengths are in units of pounds. Lengths and buoy dimensions are in feet. Hawser and chain sizes are in inches.

It would be possible to alter the contents of the inventories by rewriting the COMPDT subroutine. The subroutine is called once each time a component check or design selection is made. It is presently set up to avoid re-calculating entries after the first call. The program uses the items in the arrays to search for the appropriate entries. The appropriate values are then selected, scaled without altering the arrays, and used. Minor changes could be made without changing the calling program. More extensive changes or generalizations may require some modifications (not major) in the calling program.

A listing of the inventories is presented in Appendix D of the User's Manual.

Table 3.3. Scratch Storage Common Blocks

```
 COMMON/CDCAL/ AMAX,OMS,OMG,RTIN,YSAVE,IST

 COMMON/CHKDAT/ NELCK,FELT(3,2),INVFLG

 COMMON/FRQDAT/ SPECA,SPECB,DOMG,OMGMN,OMGMX,AMPMN,FRCFAC,FACLEN,
1 TIMFAC,IBFG,IUNRES,IDRITR,ICONMS,ICMCHF,IFRQUP,IROLIT
2 ,NFILEF,NOB,NOH,NOK,NRV,MNOB,MNOH,MNOK,MNRV,ISHPFL,ITCONF,NSOLN,
3  ELL,TMAS,BAM(30),B44S(8),DA(6,6),DB(6,6),DC(6,6),GMU(6,6),
4  HDG1(30),RANG(8),WAVEL(30),OMG,NFREQS,NEWCON,NEWRED,VDUM(3),
5  DRFTFR(3),TEMP(6,6),GHED,NSRDC,OM2,WVLN,WVAMP,WVSLP,NS3

 COMMON/HEDCHR/ IDAY,ITIME,HED(20)

 COMMON/HEDDAT/ IPAGE,NLINES,MXLINE,NWORDS,WORDS(100),NHED,NOLINE

 COMMON/RETAPE/IRST,NTAPE,NFLILE

 COMMON/SHPTAP/ SCALE,TDEPTH,TBLOCK,TSLT,TSAE,TSAS,TSWL,TSB,TSK,
1 TSDSP,TSAP

 COMMON/SHPLBL/ SHPCAP(12),WLBL,CLBL,LLBL,VLBL
```

Table 3.4. Common Blocks for Data Tables

```
 COMMON/COMPNT/ ATYPE(3,6),ANCTAB(5,16,6),NANCR(6),BTYPE(3,2),
1 BUOTAB(7,6,2),NBUOY(2),HTYPE(3,4),HAWTAB(2,23,4),HAWSIZ(23),
2 NHAWS(4),CHAIN(31,3),NCHN,HLDFAC(6)

 COMMON/TAPES/ NIN,NOUT,NTAPE1,NTAPE2
. ,NTAPE9,NTPCHK

 COMMON/SIZE/ NINA,NINB,NINRL,NINDSP,NINPO,NINSHP,NINSTM,NINT,
1 NINC,NCOM,IFILE(4),NPRECZ,NINBI,NINCI,NINCLI,NINDSI,
2 NINPOI,NINSHI,NINSTI,NINTMI

 COMMON/TYPES/
1 DEAD,ALIVE,DYNAM,TSSS,AMODE,FREQ,CHEK,PLOT,ANEW,FINIS,
2 PROB,REST,BLOC,BODY,ELEM,FLOW,FLUI,AINVE,ALIMI,ALINE,
3 ALLOC,AMATE,ANODE,ASHIP,ASTRUM,TENS,TFUN,CURR,FIX,FREE,
4 AIMPA,AINIT,IKEEP,ALOAD,ALVAR,AMOVE,AMSOL,OUTP,PAYO,SAVE,
5 SBUO,SOLU,ASTEP,SURF,ATIME,AWIND,FSOL,SPEC,EXTE,RESU,
6 AHEAD,RAND,REGU,DONE,ANCH,ABUOY,ACONF

 COMMON/IFLAG/ IFLAGS(60)
```

4.0 STORAGE REQUIREMENTS AND VARIABLE DIMENSION

The amount of computer storage required to successfully execute an analysis case can vary with the number of nodes and elements as well as with the subanalysis options selected. Direct restrictions on the number of nodes and elements are avoided by the use of the implied dimensioning (partitioning) of COMMON/ACOM/. Since the present version of SEADYN uses an in-core solver for both the stiffness equations and the eigenvalue problem, the maximum problem size is restricted by the amount of storage available. The working space for these solutions is the /ACOM/ region. The stiffness equation solution uses the portion of /ACOM/ left after the node and element data. The eigenvalue solution copies /ACOM/ to a scratch file and uses the full length of /ACOM/ (see Section 3.1 and Table 3.1).

The size of /ACOM/ is specified in the main program, which is simply a starter deck to assign a length to /ACOM/ and call SEADYN. Besides the CDC PROGRAM statement, the main program contains:

```
COMMON/ACOM/     A(xxxxx)
NCOM=XXXXX
CALL SEADYN (NCOM)
STOP
END
```

The minimum required value for NCOM depends on the problem size, and the subanalysis options selected. The amount of data needed to store the element and node data is computed by:

```
NBASE=31*NE + 66*NN
```

The global stiffness matrix (GK) begins its storage at NBASE+1. The stiffness matrix storage format is by rows, starting at the diagonal element and going to the half-bandwidth* (IBEND). Thus, any solution which uses the global stiffness matrix will require at least NBASE + NF3*IBEND storage locations in /ACOM/ (NF3 was defined in Table 3.1). This amount is required in the MNR, RFB, VRS/VRR, and SLI solution methods. The DYN SAO with the DIM option does not use the global stiffness matrix. (DYN-SLI with moved nodes imposes some special restrictions since more storage is needed for GK, and the moved nodes must be numbered just before the slave nodes. Use of this option is highly discouraged. It is complicated to use correctly and much less efficient than the DIM solution.)

The eigenvalue solution (MODES) uses the Jacobi method and starts its working storage at the beginning of /ACOM/. It begins with a diagonal mass matrix (GMM) and a compacted version of the stiffness matrix (GKK) which has the full upper triangle of the stiffness matrix. GKK requires ½(NF3)(NF3+1) words. Next is a working area which is NF3*NF3 words. The eigenvectors (NF3 of them) end up here as the TGK array. The eigenvalues follow in the next NF3 locations. The required space is then .5*NF3*(3*NF3+5).

*The half-bandwidth is the largest number computed for any row by subtracting the row number from the number of the rightmost column which contains a nonzero entry plus one.

The frequency domain solution allows for the formation of a consistent mass matrix (CGM) which is created immediately following GK in /ACOM/. Since it is the same size as GK, the storage needed is NBASE+2*NF3*IBEND. The FREQ solution uses complex arithmetic. The system coefficient matrix is generated by copying GK and CGM into a prior portion of /ACOM/ in complex format (see Table 3.1).

The variable storage space needed for NCOM is summarized below for each SAO type:

DEAD, LIVE TSSS, DYN

NCOM = NBASE + NF3*IB

where IB = IBEND for all but DYN-DIM
IB = 0 for DYN-DIM

MODE

NCOM = .5*NF3*(3*NF3+5)

FREQ

NCOM = NBASE + 2*NF3*IBEND

CHEK

NCOM = NBASE

Storage size checks are made at the beginning of each SAO to determine if enough space is available. If not, a message is printed to indicate the space needed, and the run is aborted. Note that for problems using more than one SAO, the largest NCOM must be used.

The CDC version of SEADYN uses single precision logic except for accumulators in the simultaneous equation solvers in the SLVBAN and COMBAN subroutines (see Section 7.0). On machines with word lengths less than 60 bits the program should use double precision on most of the floating point computations. The critical computations are the length changes, stiffness matrix coefficients, and components of the force residual. The most direct and reliable approach to treating double precision is to type all floating point variables double precision. This is most readily done with FORTRAN-77 or IBM-FORTRAN. If this approach is taken, then the variable NPRECZ in the SEADYN subroutine should be set to 2. This establishes the appropriate number of words to be written and read for the restart files. When NPRECZ=2 the variables in the COMMON statements of the RESTART subroutine should not be typed double precision.

If it is decided to selectively type the variables double precision some customizing of the variable dimension process will be required. The critical variables (see Section 8.0) are listed below:

ACOM-Cross Reference (Table 3.1)

DS, DSO, DSR, XC, XO, XS, U, UP, US, UD, UDP, UDD, UDDP, UDDS, F2, GK, DU

Special Temporary Variables/Subroutine:

CL, CDX/RESIDL   CL, CDX/UPDATE

Since the ACOM cross reference requires the A array partitioning to be expended, the variables NBASE and NINA (SEADYN and MANIPR subroutines) must be increased. In addition it will be necessary to modify the $NC/_{ii}$ variables in the SEADYN Subroutine. The least troublesome approach (but storage extravaganc) is to make A double precision and to double NINA and NBASE. Then the NC_{ii} variables do not need to be adjusted. If A is typed double precision then NCOM should be doubled since it (like NINA and NBASE) count single precision floating point words.

The arrays which do not depend on the number of nodes or elements have been given fixed dimensions. Should these need to be changed, it will be necessary to make three types of changes. They are:

1. Change the dimension of the specific arrays involved. A cross reference between the COMMON involved and the descriptions of the variables in Section 8.0 will clarify which ones need to be changed (see Table 4.1).

2. Change the parameter which specifies the maximum number allowed (e.g., MXBODY).

3. Change the parameter which specifies the total number of words in the COMMON block (e.g., NINB). This is used by RESTART to determine how many words to read or write.

Care will need to be taken to assure the COMMON statements in all of the affected subroutines are changed. It should be noted that making such changes causes the restart files to be unique and not accessible to other versions of the program or to the compatible SEAPLT graphics program.

Table 4.1 is a list of the array dimension limits with the arrays and parameters involved. Table 4.2 lists other program size restrictions.

Table 4.1. Fixed Dimension Array Data

Item	Limit	Variable Name	Common Size	Arrays Involved
Bodies in BODY table	50	MXBODY	NINB NINBI	BAMC(50) BLEN(50) BMOM(50) BOMAS(50) BOVOL(50) BSCD(50) BWND(50) DBU(50) CYLRMS(50) IDRB(50)
Body locations	50	MXBLOC	NINB NINBI	FBUSR(50) SBAMP(50) UBS(50) IBS(50) IBU(50) JSLP(2,50) LBODN(50) MBLN(50) NMOTN(50) BUOKP(3,50)
Limit Conditions table	50	MXLIMS	NINB NINBI	CORDLM(50) RELFAC(50) TOLIM(50) JANCR(50)
Limit Locations	50	MXLLOC	NINBI	KONECT(10,50) LIMNOD(50) LIMSET(50)
Lines connected to a limited node	10		NINBI	KONECT(10,50)
Cable material tables	10		NINC NINCI	CABMAS(10) CAMC(10) DIAM(10) E(20,10) STR(20,10) TT(20,10) G3(10) TENULT(10) TTD(10) TTK(10) IDRG(10) JFLCOD(10) MATDMP(10) ME(10) MED(10)

Table 4.1. (Continued)

Item	Limit	Variable Name	Common Size	Arrays Involved
Entries in any material table	20			E(20,10) STR(20,10) TT(20,10)
Entries in FLUID table (program logic also involved here)	2		NINC	FDEPTH(5) FGAM(5) FVISC(5)
Ship/Platform rigid bodies (program logic limits FREQ solution to only one ship)	3		NINSHP NINSHI	APROP(3) BLOCK(3) CPROP(3) CR(3) CS(3) CURCOE(20,3,5) WNDCOE(20,3,5) FACH(3) FSFRC(3) FSFRW(3) FSLEN(3) FSVEL(3) HEAD(3) ISHIP(3) LSHP(3) PROPF(3) RATL(3) SAE(3) SAS(3) SBEAM(3) SDRFT(3) SOSPV(3) SFACW(3) SHPKP(3,3) SLT(3) SLWL(3) TSAP(3) WDEPTH(3)
Payout/reel-in ends (must be less than or equal to the number of moved nodes allowed)	5		NINPO NINPOI	AMAXL(5) CURLEN(5) DLREF(5) DPTMF(5) ESP(2,5) PAYV(5) PTMF(5) TFSAV(5) JOP(5) JPELT(5) MULMAT(5) NELPOI(5)

Table 4.1. (Continued)

Item	Limit	Variable Name	Common Size	Arrays Involved
				NGROW(5) NNPOI(5) NPOVRY(5) NSHRNK(5)
Moved nodes in DYN or TSSS (Note: the row dimension is 3 times the number)	5		NINPO NINT NINTMI	UMVB(15,3) UMVBP(15,3) FTI(15) TMFRM(15) UB(15) IB(5) IMTMF(15) JB(15)
Nodal components with imposed displacements in DEAD, LIVE or MODE	30		NINDSP NINDS1	DSPC(30) DISPP(30) IDIS(30,3) NFKEEP(30)
Strum strings	30		NINST1	ISTRNG(30) KSTRNG(20,30)
Elements in a strum string	20		NINSTM NINST1	QST(20) STLEN(20) KSTRNG(20,30)
Number of flow fields in FLOW	10	MXFLOW	NINC NINCI	FLPAR(10,10) IFLCOD(10)
Parameters per flow field	10		NINC	FLPAR(10,10)
Time functions defined by TFUN	20	MXTFUN	NINT NINTMI	ITFCOD(20) TPARM(20,20)
Parameters per time function	20		NINT	TPARM(20,20)
Load variation sets defined by LOAD/LVAR	3		NINT NINTMI	FTF(3) TMFRF(3) ILF(3)

Table 4.2. Problem Size Restrictions

Restriction	Limit	Comments
Ships/platforms in FREQ SAO	1	Program logic limit, requires new coding to remove
Catenary lines of generated nodes	20	Array dimensions in INPT, CATGEN, INTLIZ subroutines
Lines connected to a node where anchor holding power CHEK is made	20	Array dimensions and counter check in COMCHK subroutine
PROB + REST data sets in any run	50	Array dimensions on title cards read in SEADYN and FREINP subroutines
Rigid format data sets	1	Program logic limitation in FREINP and SHIPIN subroutines
Wave headings on ship motion file	30	File format
Wave length on ship motion file	30	File format
Roll angles on ship motion file	8	File format
Wind velocities on ship motion file	5	File format
Wind headings on ship load file	20	File format
Current velocities on ship load file	5	File format
Current headings on ship load file	20	File format

The total size of the CDC version of SEADYN is 156,000 (octal) plus the size required by the ACOM COMMON. Selecting NCOM to be 8500 (decimal), the total program size is 176,000 (octal). A reduction in total storage can be achieved by segmenting the program. Input for one approach using the CDC segmented loader is shown below.

```
TREE      SEAPAY-(INPT, SAORD, TRANS, EIGNS, FRQSLN, COMCHK)
GLOBAL    BUOYS, CABLE, CDCAL, CHKDAT, COMPNT, CONTRL, DSPCON
GLOBAL    PAYOUT, RETAPE, SHIPS, STRUM, HEDDAT, TAPES, SIZE, TYPES
```

```
          GLOBAL    IBUOYS, ICABLE, ICNTRL, IDSPCN, IPAYOT
          GLOBAL    ISHIPS, ISTRUM, ITIMED
          GLOBAL    HEDCHR, LOGIC, ACOM
          GLOBAL    SHPTAP, SHPLBL, IFLAG
FRQSLN    GLOBAL    FRQDAT
          END
```

This approach to segmentation gives a maximum size of 126,000 (octal) plus ACOM. More complex tree structures can be devised to shrink this size but the complicating factor is that the FRQSLN branch of the tree calls the STATIC group of subroutines for wave drift force updates (see Figure 2.2)

5.0 DATA FILES AND AUXILIARY STORAGE

SEADYN uses the following FORTRAN files:

FILE CODE	FILE NAME	MODE	DESCRIPTION
01		binary	Restart file for DEAD SAO output; may be used for input.
02		binary	Restart file for LIVE/TSSS SAO output; may be used for input.
03		binary	Restart file for DYN SAO output; may be used for input.
04		binary	Optional restart input file.
05	NIN	coded	System input file; read only by FREINP. Defined in SEADYN and carried in COMMON/TAPES/.
06	NOUT	coded	System output file; written by various routines, primarily those calling PAGHED (see Section 3.0). Defined in SEADYN and carried in COMMON/TAPES/.
08	NSRDC	binary	Ship motion file; read by SHPMOF and SHPRED subroutines.
09	NTAPE9	binary	Scratch file for temporary storage of the contents of COMMON/ACOM/, etc. in MODE and FREQ SAOs.
10		binary	Ship load file; written by SHIPIN and read by SHPLDS.
11		binary	FREQ steady state response solutions; written by FRQSLV and read by FRQSLV.
12		binary	FREQ RAO outputs; written by FRQSLV and read by FRQRND and FRQREG.
13	NTPCHK	binary	Used to pass the contents of COMMON/ACOM/ from FRQSLN to COMCHK for multiple wave heading solutions.
15	NTAPE1	binary	Deciphered card images from free-form input; written by FREINP and read by FFLD.
16	NTAPE2	coded	Scratch file for rigid format input data; written by FREINP and read by SHIPIN.
20		binary	Mode shape (eigenvectors) output; written by EIGNS.

FILE CODE	FILE NAME	MODE	DESCRIPTION
21		binary	Scratch file for mode shape calculations. Used to move the system stiffness matrix to a new position in COMMON/ACOM/ in the needed format. Done in EIGNS.

5.1 Restart File Structure

The SEADYN program creates up to three restart files (one each for the DEAD, LIVE, and DYN subanalyses). Multiple selections of a subanalysis type simply extend the file unless a rewind is signalled by the SAVE data record. A counter (IFILE array) is provided for each of the files to keep track of how many restart records have been written. Each time the file is rewound, the counter for that file is set to zero, and a label record is written. The write statement is:

```
     WRITE(NFILE) (TITLE(I),I=1,NHED),NINA,NPRECZ
```

Each restart save operation uses the following write statement:

```
 WRITE(NTAPE) (A(I),I=1,NINA),(B(I),I=1,NINB),(C(I),I=1,NINC),
.  (RL(I),I=1,NINRL),(P(I),I=1,NINPO),(T(I),I=1,NINT),
.  (SH(I),I=1,NINSHP),(DP(I),I=1,NINDSP),(STM(I),I=1,NINSTM),NFILE
.  ,(IAABU(I),I=1,NINBI),(IAACA(I),I=1,NINCI)
.  ,(IAACL(I),I=1,NINCLI),(IAADS(I),I=1,NINDSI)
.  ,(IAAPO(I),I=1,NINPOI),(IAASHP(I),I=1,NINSHI)
.  ,(IAASTM(I),I=1,NINSTI),(IAATIM(I),I=1,NINTMI)
.  ,DLD,WLD,DYN,CHECKR,NOVEL,NOITER,NOFLUD,NOLOAD
.  ,FEEDBK,POUT,REFUP,STEPUP
```

5.2 Ship Motion File Structure

The Ship Motion File is organized in logical reocrds. The specific contents of each record will be described below. There are seven distinct record types. The first two records contain data which are independent of wave heading or wavelength. Record types 3 through 7 are dependent on heading and wavelength and are repeated in a nested loop fashion. The overall form is:

```
                                      Record 1
                                      Record 2
           ___________________________________
  Loop    |       Loop      ┌─────────Record 3
  on      |       on        |         Record 4 ——— (present on
  Wave    |       Wave      |         Record 5      first wavelength
  Length  |       Heading   |         Record 6      only for NCEL
          |                 └─────────Record 7      formatted files)
          |___________________________________
```

The wave headings are assumed to be listed in decreasing order with +180 degrees being the largest allowed. The interpolation routines assume the values given for +180 degrees will be used for -180 degrees; therefore, data for -180 degrees need not be given.

The wavelengths are assumed to be listed in decreasing order (i.e., increasing frequency order).

The individual records of the file are described in terms of the Fortran read/write lists associated with each record.

<u>RECORD 1</u> NAME 1, NAME 2, NAME 3

Three Hollerith variables providing identifying data.

<u>RECORD 2</u> (TITO(I), I=1, 12), WORD, WORD 2, WORD 3, ELL, BEAM, DRAFT, TVOL, TMAS, TPST, ZG, CBV, NOB, (FN(I), I=1, NOB), NOH, (HDG1(I), I=1, NOH), NOK, (BAM(I), I=1, NOK), VNY, GRAV, NRV, (RANG(I), I=1, NRV), ((GMU(I,J), J=1, 6), I=1,6), ((DC(I,J), J=1,6), I=1,6)

TITO	=	Hollerith title consisting of 12 6-character words
WORD	=	length unit label (6-character Hollerith)
WORD 2	=	force unit label (6-character Hollerith)
WORD 3	=	moment unit label (6-character Hollerith)
ELL	=	Ship's length (L)
BEAM	=	Beam (L)
DRAFT	=	Draft (L)
TVOL	=	Ship's volume; obtained from $(ELL/2)^3$. TVOL
TMAS	=	Ship's mass (FT^2L^{-1})
TPST	=	Longitudinal distance from c.g. to forward most station; obtained from (ELL/2) . TPST
ZG	=	Vertical distance from water line to c.g., (+ up) (L)
CBV	=	Vertical distance from water line to center of buoyancy (+ up); obtained from ELL . CBV
NOB	=	Number of speeds (SEADYN expects only one)
FN(I)	=	The Froude numbers for each speed
NOH	=	Number of wave headings
HDGI(I)	=	The wave headings listed in decreasing order starting with 180 degrees and proceeding no further than -180 degrees + $\Delta\theta$
NOK	=	Number of wavelengths
BAM(I)	=	Nondimensional wavelength in decreasing order, λ = ELL . BAM(I)
VNY	=	Fluid viscosity (L^2T)
GRAV	=	Gravitational acceleration (LT^{-2})
NRV	=	Number of roll angles
RANGE(I)	=	The values of roll anges (radians) listed in increasing order
GMU(I,J)	=	The nondimensional mass matrix
DC(I,J)	=	The nondimensional hydrostatic restoring matrix

<u>RECORD 3</u> MM, HDGI(MM), JJ, FN(JJ), LL, BAM(LL)

MM	=	Heading number
JJ	=	Speed number
LL	=	Wavelength number

RECORD 4 ((DA(I,J), J=1,6), I=1,6), ((DB(I,J), J=1,6), I=1,6)

DA(I,J) = The nondimensional added mass matrix for the current combination of heading, speed, and wavelength

DB(I,J) = The nondimensional wave damping matrix

RECORD 5 (BOD(I), BOD(I+3), BEV(I), BEV(I+3), I=1,3)

BOD, BEV = The nondimensional wave force coefficient

RECORD 6 B44S(I), I=1, NRV)

B44S(I) = The nonlinear roll damping terms which are added to the damping matrix depending on the size of the roll angle (nondimensional)

RECORD 7 ((TX(I,J), I=1,7), J=1,7), ((TY(I,J), I=1,7), J=1,7), ((TMI,J), I=1,7), J=1,7), (TP(I), I=1,7)

The complex nondimensional drift force coefficients

5.3 Ship Load File Format

The ship load file is set up to be a library of ship characteristics and loading tables. The file contains one logical record for each ship catalogued. It is written in binary form with the following FORTRAN statement:

```
WRITE(10) NWIND, NETHETW, WNDVEL, WNDHED, WNDCOE, SCALE, NCRNT,
          NTHETC, CURVEL, CURHED, CURCOE, TDEPTH, TBLOCK, TSLT,
          TSAE, TSAS, TSWL, TSB, TSD, TSDSP, TSAP, SHPCAP, WLBL,
          CLBL, LLBL, VLBL
```

Consult Section 8.0 for descriptions of the variable and Section 3.2 for array sizes.

5.4 Mode Shape File Format

The output of natural frequencies and mode shapes can be output on file 20. The file contains one record for each natural frequency. Each record is written as:

```
WRITE(20) I, EIGEN(I), FREQ, PERD, (TGK(J,I), J=1,NF3)
```

where:
- I = The mode number
- EIGEN(I) = The circular frequency (radians/sec)
- FREQ = The natural frequency (Hz)
- PERD = The natural period
- TGK = The eigenvector (mode shape)
- NF3 = The number of degrees of freedom

6.0 RESTART CAPABILITIES

The restart files mentioned previously allow for the recovery of data for various configurations of the modeled system. The methods for using this capability are explained in Section 6.0 of the User's Manual. When restart is used in a separate run from the one that created the saved file, the file may be designated as any file code recognized by the system since the file code is given in the input data. The usual procedure is to use codes 01 through 04, as explained in Section 5. It should be recognized that normal execution may require the re-use of some files. By using file code 04 as restart input, the user is guaranteed the file will not be used for output.

The restart procedure reads the title record from the restart file and performs a comparison on the first word if requested. It then spaces down the file to the requested record number by reading each record. The last record read then occupies the COMMON blocks mentioned in Sections 3.1 and 3.2. The restart activity is aborted if the first word comparison fails or if the current size of COMMON/ACOM/ is too small to receive the number of words written when the file was created.

7.0 DESCRIPTIONS OF THE SUBROUTINES

Each of the subroutines is described in this section. Cross references for CALLS and CALLED BY are also given. These cross references omit system library functions and subroutines, such as SQRT, COS, SIN, etc. However, those routines calling EOF, DATE, TIME, and ENCODE/DECODE are indicated since this may be useful in conversion to other mechaines. These particular routines are listed here for convenience:

CALLS	SUBROUTINE
EOF	FREINP, FFLD
DATE	SEADYN (results output by PAGHED)
TIME	SEADYN (results output by PAGHED)
ENCODE/DECODE	FREINP, SELCTS, SELECT

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
ADJMAS	9	EQTION DYNFBK NRAPIT	MNPRDT	BUOYS CABLE CONTRL LOGIC TAPES TIMED	Adjust nodal force summation for tangential added mass (i.e., remove residual added mass from tangential direction)
AMPHAZ	5	FREQREG FRQSLV SPONLY			Get response amplitude and phase for a set of complex numbers.
BANDES	2	INPT			Estimate bandwidth
BNMOVE	10	STATIC STPDYN NRAPIT	TVARY	BUOYS CABLE CONTRL DSPCON LOGIC PAYOUT TIMED	Impose boundary movement for MOVE, SBUO, and fixed nodes for DYN and TSSS.
BUODYN	5	FRQSLV	CVCTRN SPONLY TATT TRNSHP	BUOYS CONTRL FRQDAT SHIPS TAPES	Compute spherical buoy dynamic coefficients for frequency domain equations.
BUOSTF	4	STFGEN		BUOYS	Get stiffness matrix for mooring buoys.
CABTRN	4	SHPFIX	CROSS		Get local-to-global transformation matrix for line elements.
CATFRC	9	CATSTF CATRES	PCAFX2	TAPES	Computer end forces and stretched length for bottom-limited catenary element.
CATGEN	17	INPNOD			Generate nodes along a catenary curve.
CATRES	19	RESIDL	CATPRC CROSS MVPRDT	BUOYS CABLE CONTRL	Compute internal forces for bottom-limited catenary element for force residual.
CATSTF	14	STFGEN	CATFRC TATT	BUOYS CABLE CONTRL TAPES	General stiffness matrix for bottom-limited catenary element.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
CBLDMP	12	FRQSLV	CABTRN CXSLVR DRAGO TATT	CABLE CONTRL	Calculate linearized damping terms for line elements and assemble into complex system matrix.
CCOMLT	6	FRQSLV			Form complex matrix triple product and dot product.
CD	1	STRUMR SIMP			Function to compute local drag coefficient ratio for strum calculation.
COMBAN	8	FRQSLV SPONLY			Complex simultaneous equation solution using symmetric banded row storage format.
COMCHK	18	MANIPR	FFLD LOUPD PAGHED RESTART	BUOYS CABLE CHKDAT COMPNT CONTRL DSPCON HEDCHR HEDDAT SHIPS SIZE TAPES	Check for component adequacy.
COMPOT	1	INPUT		COMPNT	Define, convert, and print component inventory.
COMPRP	13	UPDATE RESIDL UPDATE	DMPFRC MPROP	CABLE CONTRL PAYOUT	Computer element material properties, strain and load for multimaterial payout element.
CONCNT	3	INPT		BUOYS CONTRL	Count connections to limited nodes and bodies.
CONMAS		FRQSLV			Get consistent mass matrix.
CPLOTR	41	MANIPR			Dummy routine for eventual plot interface.
CRCALL	4	SHPDEF			Calculate ship's hull resistance coefficient for analytical load functions.
CROSS	3	CABTRN CATRES STRUMR UPDATE			Vector cross product.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
CURREN	2	LDUPD MANIPR STRUMR	CURUSR TVARY	CABLE CONTRL TIMED LOGIC	Define components of current for each node.
CURUSR	6	CURREN			User subroutine for defining current field.
CVCTRN	8	FRQREG BUODYN FRQSLV	MLTPLY TMLTPLY		Coordinate transformation on a complex vector.
CXSLUP	5	FRQSLV	MVPRDT		Complex slave update.
CXSLVR	11	CBLDMP	MLTPLY		Store complex slave partitions for stiffness or mass matrix.
DEPCOR	3	SHPDEF			Function to compute depth correction for ship load tables.
DMPFRC	10	COMPRP RESIDL UPDATE		CABLE CONTRL TIMED	Computes damping forces for material damping.
DRAGCO	7	CBLDMP LDUPD			User subroutine for computing drag coefficients.
DTCALC	6	TRANS STPDYN SAORD	PAGHED	CABLE CONTRL HEDDAT TAPES TIMED	Estimates upper bound on time step for DIM dynamic solution.
DYNFBK	42	STPDYN NRAPIT	ADJMAS LDUPD MSTRMS RESIDL SHPFIX SLAVLD STFGEN SLVBAN	BUOYS CABLE CONTRL SHIPS LOGIC TAPES TIMED	Transient solution of residual feedback equations using Newmark Beta Method.
EIGNS	14	MODES STRUMR	JACOBI	ACOM	Set up eigenvalue solution
EQTION	41	STPDYN	ADJMAS LDUPD MSTRMS RESIDL SHPFIX SLAVLD STFMLT	BUOYS CONTRL LOGIC TAPES TIMED	Form terms of dynamic equation for SLI and DIM solutions.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
ERROR	4	FREINP FFLD			Error message processor for free-field reader.
FFLD	5	SEADYN INPT SAORD FRQFRD COMCHK FRQREG FRQRND MANIPR	ERROR EOF		Reads binary records processed by the free-field reader.
FREINP	5	SEADYN INPT SAORD FRQFRD COMCHK FRQREG FRQRND MANIPR	ERROR EOF		Reads binary records processed by the free-field reader.
FREINP	5	SEADYN	EOF ERROR SELCTS SELECT SHIFT ENCODE DECODE	TAPES	Free-field reader -- decodes free-field records and writes a binary interpretation of the input data. It also copies rigid format data over to a scratch file.
FRQFRD	4	FRQSLN	PAGHED FFLD	CONTRL DSPCON FRQDAT HEDDAT TAPES	Read input data for FREQ SAO.
FRQREG	8	FRQSLN	AMPHAZ CVCTRN FFLD PAGHED	CONTRL FRQDAT HEDDAT HEDCHR SHIPS TAPES TYPES IFLAG	Calculate regular wave response data for FREQ SAO.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
FRQRND	10	FRQSLN	FFLD PAGHED	CABLE CONTRL FRQDAT HEDDAT HEDCHR SHIPS TAPES TYPES IFLAG	Calculate random response statistics for FREQ SAO.
FRQSLN	48	MANIPR	RESTART STATIC UPDATE	ACOM BUOYS CABLE CONTRL SHIPS TIMED TYPES IFLAG FRQDAT HEDDAT HEDCHR TAPES	Controller for the FREQ SAO.
FRQSLV	50	FRQSLN	AMPHAZ BUODYN CBLDMR CCOMLT COMBAN CONMAS CVCTRN CXSLUP PAGHED SHPRED SFONLY STFGEN TATT TENRSP	BUOYS CONTRL FRQDAT HEDDAT HEDCHR SHIPS TAPES	Solve for frequency reponses for FREQ SAO and set up RAO's.
INPBDY	3	INPT	PAGHED	BUOYS CONTRL HEDDAT HEDCHR TAPES	Input body tables data.
INPBLC	4	INPT	PAGHED	BUOYS CONTRL HEDDAT HEDCHR TAPES	Input body location data.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
INPGLT	10	INPT	PAGHED	CONTRL HEDDAT HEDCHR TAPES	Input element data and generate missing data.
INPFLD	4	INPT	PAGHED	CONTRL HEDDAT HEDCHR TAPES	Input flow tables.
INPFLU	3	INPT	PAGHED	CONTRL HEDDAT HEDCHR TAPES	Input fluid data
INPLIM	3	INPT	PAGHED	BUOYS CONTRL HEDDAT HEDCHR TAPES	Input limit set tables.
INPLLC	3	INPT	PAGHED	BUOYS CONTRL HEDDAT HEDCHR TAPES	Input limit location data.
INPMAT	2	INPT	PAGHED	CABLE CONTRL HEDDAT HEDCHR LOGIC TAPES	Input material tables.
INPNOD	10	INPT	PAGHED CATGEN	CONTRL HEDDAT HEDCHR SHIPS TAPES	Input nodes and lines of nodes.
INPSTM	3	INPT	PAGHED	CONTRL HEDDAT HEDCHR TAPES STRUM	Input strum string data.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
INPT	42	MANIPR	BANDES COMPDT CONCNT FFLD INPBDY INPBLC INPELT INPFLO INPFLU INPLIM INPLLC INPMAT INPNOD INPSTM INPTEN INPTIM MPROP PAGHED SHIPIN SHPINP INTLIZ	BUOYS CABLE CONTRL PAYOUT SHIPS STRUM TIMED HEDDAT HEDCHR TAPES TYPES IFLAG	Input new problem data and initialize parameters, calculate lengths, added masses, weight, etc.
INPTEN	4	INPT	PAGHED	CONTRL HEDDAT HEDCHR TAPES	Input tension data.
INPTIM	4	INPT	PAGHED	CONTRL HEDDAT HEDCHR TAPES TIMED	Input time function tables.
INTLIZ	45	INPT	UPDATE MPROP	BUOYS CABLE CONTRL LOGIC SHIPS TAPES	Initialize new problem data, compute lengths and initial tension data.
INTLSA	4	SAORD		BUOYS CABLE CONTRL CHKDAT DSPCON PAYOUT SHIPS STRUM	Initialize solution parameters and set defaults of subanalysis options.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
				TIMED TYPES IFLAG RETAPE	
INTLWM	12	INPT	PAGHED	BUOYS CABLE CONTRL LOGIC SHIPS TAPES	Compute masses and weights for new problem.
JACOBI	13	EIGNS			Solves the linear eigenvalue problem using the Jocobi method.
LDNTRP	13	SHPLDS			Table look up for ship's static loads.
LDUPD	15	NRAPIT STEP EQTION DYNFBK COMCHK TRANS	CURREN DRAGCO SHPLDS	BUOYS CABLE CHKDAT CONTRL PAYOUT SHIPS TIMED LOGIC TAPES	Compute fluid drag loads on bodies, lines and ships.
LIMCHK	10	RESIDL STFGEN	TVARY	BUOYS CABLE CONTRL DSPCON SHIPS TIMED TAPES LOGIC	Check limit conditions and fix or free components as needed.
MAIN	N/A	N/A	SEADYN	ACOM	Main program. Establishes the size of ACOM.
MANIPK	42	SEADYN	COMCHK CPLOTR CURREN FFLD FRQSLN INPT MODES OUTPUT PAGHED	BUOYS CABLE CHKDAT CONTRL DSPCON PAYOUT SHIPS RETAPE STRUM	Manipulative routine to control the execution of the subanalysis modules.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
			SAORD STATIC STRUMR TRANS UPDATE	LOGIC HEDDAT HEDCHR TAPES TIMED SIZE TYPES IFLAG	
MASMOD	13	PAYUPD		BUOYS CABLE CONTRL PAYOUT SHIPS TAPES	Make mass and weight adjustments for payout elements.
MLTPLY	9	CVCTRN CXSLVR SHPFIX SHPSTF SLAVER STFGEN STRUMR TATT			Matrix multiply.
MODES	40	MANIPR	EIGNS STFGEN	ACOM CONTRL DSPCON	Set up and execute MODE SAO-eigenvalue solution.
MPROP	10	COMPRP INPMAT INPT RESIDL TENRSP UPDATE			Material property table lookup.
MSTRMS	0	DYNFBK EQTION NRAPIT			Dummy routine intended for eventual use with transient dynamics with slave nodes.
MVPRDT	5	ADJMAS CATRES CXSLUP SHPLDS SHPSTF SLAVUP STFGEN			Premultiply a vector by a matrix and get the dot product (square) of the result.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
NRAPIT	41	STATIC TRANS	ADJMAS BNMOVE DYNFBK COUPD MSTRMS OUTPUT PAGHED RESIDL SERCH1 SHPFIX SLAVLD SLAVUP SLVBAN STFGEN STFMLT TVARY	BUOYS CABLE CONTRL DSPCON SHIPS TIMED LOGIC HEDDAT HEDCHR TAPES	Modified Newton-Raphson solution routine for statics and dynamics.
OUTPUT	8	SEADYN MANIPR NRAPIT STEP STATIC TRANS	PAGHED RESTART	CONTRL PAYOUT TIMED HEDDAT HEDCHR TAPES LOGIC SIZE SHIPS	Output routine for node positions and velocities and element tensions.
PAGHED	0	COMCHK DTCALC FRQFRD FRQREG FRQSLN FRQSLV INPBDY INPBLC INPELT INPFLO INPFLU INPLIM INPLLC INPMAT INPNOD INPSTM INPT INPTEN INPTIM MANIPR NRAPIT OUTPUT PAYUPD		HEDDAT HEDCHR SIZE TAPES	Write page heading for output.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
		SAORD SEADYN SHPINP SHPMOF STPDYN			
PAYUPD	21	STATIC STPDYN	MASMOD PAGHED TVARY	CABLE CONTRL PAYOUT TIMED TAPES HEDDAT HEDCHR LOGIC	Compute pay-out/reel-in data for changing lengths and mitosis.
PCAFX2	14	CATFRC			Compute end forces for a catenary element with given end positions.
PSIN	1	STRUMR SIMP			Compute mode shape amplitude for strum drag amplification.
RANDIN	3	TVARY			Dummy routine for NCEL random signal input.
RESIDL	40	STEP NRAPIT EQTION DYNFBK	COMPRP DMPFRC LIMCHK MPROP SHPSTF	BUOYS CABLE CONTRL DSPCON PAYOUT SHIPS STRUM TIMED TAPES LOGIC	Compute internal nodal point forces (element forces) for the force residual vector. Also updates lengths, tension, and material properties for iterative solutions.
RESTART	5	SEADYN OUTPUT FRQSLN COMCHK		ACOM BUOYS CABLE CONTRL DSPCON PAYOUT TIMED SHIPS STRUM LOGIC SIZE TAPES HEDDAT HEDCHR	Read/write restart data records.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
SAOCUR	3	SAORD		HEDDAT LOGIC TAPES	Process CURR input record.
SAOFOF	5	SAORD	PAGHED	CONTRL HEDDAT TAPES	Process FIX/FREE input records.
SAOIMP	0	SAORD		BUOYS HEDDAT TAPES	Process IMPA input record.
SAOINI	6	SAORD		HEDDAT TAPES	Process INIT input records.
SAOLOD	8	SAORD		HEDDAT LOGIC TAPES	Process LOAD input records.
SAOLVA	4	SAORD		HEDDAT TAPES	Process LVAR input record.
SAOMOV	6	SAORD		DSPCON HEDDAT TAPES TIMED TYPES	Process MOVE input records.
SAOPAY	3	SAORD		HEDDAT LOGIC PAYOUT TAPES	Process PAYO input records.
SAORD	9	MANIPR	DTCALL FFLD INTLSA PAGHED SAOCUR SAOFOF SAOIMP SAOINI SAOLOD SAOLVA SAOMOV SAOPAY SAOSAV SAOSBN SAOSOL SAOSTP SAOSOW SAOTIM	BUOYS CABLE CONTRL CHKDAT DSPCON HEDDAT HEDCHR PAYOUT SHIPS STRUM TAPES TIMED TYPES IFLAG SIZE RETAPE LOGIC	Controlling routine of input and initializing subanalysis option (SAO) data.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
SAOSAV	4	SAORD		HEDDAT TAPES TYPES	Process SAVE input record.
SAOSBU	5	SAORD		BUOYS HEDDAT TAPES	Process SBUO input record.
SAOSOL	3	SAORD		CONTRL HEDDAT TAPES TIMED	Process SOLU input record.
SAOSOW	1	SAORD		HEDDAT SHIPS TAPES	Process SURF/WIND input records.
SAOSTP	7	SAORD		HEDDAT TAPES TYPES	Process STEP input record.
SAOTIM	4	SAORD		HEDDAT TAPES TYPES	Process TIME input record.
SEADYN	1	MAIN	DATE FFLD FREINP MANIPR PAGHED RESTART SEAMES TIME	ACOM BUOYS CABLE CDCAL CHKDAT COMPNT CONTRL DSPCON LOGIC PAYOUT RETAPE SHIPS STRUM TAPES TIMED TYPES IFLAG HEDDAT HEDCHR SIZE	Primary controlling routine. Processes title cards and PROB/REST data records. Call for restart read (if needed) and establishes the variable dimension position of main data items in ACOM.
SEAMES	0	SEADYN		HEDDAT HEDCHR TAPES	Prints user information messages at the beginning of output.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
SELCTS	1	FREINP	ENCODE		Interprets the solution option input codes and translates to numeric value.
SELECT	2	FREINP	ENCODE	TYPES IFLAG	Interpretes the keywords from free-field input and translates to numeric values.
SERCH1	7	NRAPIT			Performs linear interpolation for 1D search accelerator for MNR solution.
SHIPIN	0	INPT		CONTRL SHIPS TAPES SHPTAP SHPLBL	Reads the static ship load file data placed on file code NTAPE2 as Rigid format data by FREINP and translates it to the ship load file (binary form).
SHPDEF	3	SHPINP	CRCALC DEPCOR	HEDDAT HEDCHR SHPLBL SHPTAP TAPES	Process SHIP input data.
SHPFIX	4	DYNFBK EQTION NRAPIT STEP	CABTRN MLTPLY TMLPLY	BUOYS SHIPS	Adjust residual for ship and mooring buoy constraints. Unless SHIPK data are input, ships are fixed in HEAVE, PITCH, and ROLL for static analyses. Unless more than two line attachments are made to mooring buoys, their ROLL response will be fixed.
SHPINP	3	INPT	PAGHED SHPDEF	CONTRL HEDDAT HEDCHR SHIPS TAPES	Set up for reading ship input data.
SHPLDS	2	LDUPD	LDNTRP MVPRDT TRNSHP	CONTRL SHIPS SHPLBL SHPTAP	Compute ship static loads.
SHPMOF	1	FRQSLN	PAGHED	CONTRL FRQDAT HEDDAT HEDCHR SHIPS TAPES	Initialize data from ship motion file.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
SHPRED	24	FRQSLV			Read data and interpolate from ship motion file.
SHPSTF	9	STFGEN RESIDL	MLTPLY MVPRDT	SHIPS	Compute and assemble ship stiffness matrix or force residual contribution.
SIMP	6	STRUMR	F (PSIN) (CD)		Simpson rule quadrature. External function F provided in calling sequence.
SIMP1D	18	STFGEN	MVPRDT TATT	TAPES	Compute stiffness matrix for 1D simplex element (cable/truss) and assemble in global stiffness matrix.
SLAVER	10	STFGEN	MLTPLY		Store stiffness terms for master node rotation.
SLAVLD	7	DYNFBK EQTION NRAPIT STEP TRANS			Transfer loads at slave nodes to master nodes.
SLAVUP	8	NRAPIT STEP UPDATE	MVPRDT TRANSHP		Recover/update displacements and positions for slave nodes.
SLVBAN	8	DYNFBK NRAPIT STEP			Decompose and solve system of simultaneous linear algebraic equations. Assumes compacted symmetric banded row format.
SPONLY	11	BUODYN FRQSLV	AMPHAZ COMBAN		Solve for unrestrained ship response.
STATIC	46	MANIPR FRQSLN	BNMOVE NRAPIT OUTPUT PAYUPD STEP STRUMR TVARY UPDATE	CONTRL DSPCON HEDDAT HEDCHR LOGIC PAYOUT RETAPE SHIPS STRUM SIZE TAPES TIMED	Control the static solutions: DEAD, LIVE, TSSS.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
STEP	41	STATIC	LDUPD OUTPUT RESIDL SHPFIX SLAVLD SLAVUP SLVBAN STEPAD STEPDP STEPOV	BUOYS CABLE CONTRL DSPCON HEDCHR HEDDAT LOGIC SHIPS TAPES	Static solution using SLI, RFB, VRS, VRR methods.
STEPAD	22	STEP	SLAVUP	BUOYS CONTRL DSPCON HEDCHR HEDDAT TAPES	Makes solution parameter adjustments for the VRS, VRR methods.
STEPDP	11	STEP		BUOYS CABLE TAPES CONTRL DSPCON TIMED LOGIC SHIPS	Compute residual ADTM and damping for VRR solution.
STEPOV	12	STEP		CONTRL DSPCON TAPES	Adjust for limit overshoot for STEP subroutine.
STFGEN	40	DYNFBK EQTION MODES NRAPIT STEP STPDYN FRQSLV STRUMR	BUOSTF CATSTF LIMSHK MLTPLY MVPRDT SHPSTF SIMP1D SLAVER	BUOYS CABLE CONTRL DSPCON PAYOUT SHIPS STRUM TAPES TIMED	Generate global stiffness matrix.
STFMLT	7	EQTION NRAPIT			Matrix/vector multiply using compact banded stiffness matrix format.
STPDYN	41	TRANS	BNMOVE DTCALC DYNFBK EQTION PAGHED	CONTRL HEDCHR HEDDAT LOGIC PAYOUT	Solution routine for DYN SAO. Does SLI, MNR, RFB, and DI solutions.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
			PAYUPD STFGEN TVARY	TAPES TIMED	
STRUMR	40	MANIPR STATIC TRANS	CD CROSS CURREN EIGNS MLTPLY PSIN SIMP STFGEN TATT	BUOYS CABLE CONTRL LOGIC SIZE STRUM TIMED	Estimates drag amplification due to strumming.
TATT	8	CATSTF SIMPID CBLDMP STRUMR FRQSLV	MLTPLY		Coordinate transformation of matrix A with matrix T using the form $T\ A\ T^T$.
TENRSP	11	FRQSLV	MPROP	CABLE	Compute components of dynamic tension for FREQ SAO.
TFNUSR	4	TVARY			User written subroutine for time functions.
TMLPLY	9	CVCTRN SHPFIX			Pre-multiply a matrix by a matrix transposed. $C = A^T B$.
TRANS	44	MANIPR	LDUPD NRAPIT OUTPUT SLAVLD STPDYN STRUMR TVARY UPDATE	BUOYS CABLE CONTRL DSPCON HEDCHR HEDDAT LOGIC PAYOUT RETAPE SHIPS SIZE STRUM TAPES TIMED	Controller for transient dynamics (DYN)
TRANSHP	4	SHPLDS SLAVUP UPDATE			Compute local-to-global transformation for a given heading.

NAME	NO. OF ARGS	CALLED BY	CALLS	COMMON USED	DESCRIPTION
TVARY	3	BNMOVE CURREN LIMCHK NRAPIT PAYUPD STATIC STPDYN TRANS UPDATE	RANDIN TFNUSR	CONTRL TIMED	Compute time variation functions.
UPDATE	41	MANIPR INPLIZ FRQSLN STATIC TRANS	COMPRP CROSS DMPFRC MRPROP SLAVUP TRNSHP TVARY	BUOYS CABLE CONTRL DSPCON LOGIC PAYOUT SHIPS TAPES TIMED	Update displacements, positions, tensions, strains, and lengths. Get new coordinate transformation data as needed.

8.0 DESCRIPTIONS OF MAJOR VARIABLES

This section lists the major variables in alphabetical order and gives a brief description of each. Entries in the ARRAY SIZE indicate the dimension of the array. No entry means a scalar variable. A variable name (e.g., NE) means an array which is mapped to the variable dimension working space of COMMON/ACOM/ through the MANIPR subroutine calling sequence. The length of such arrays are NE (number of elements) or NN3 (three times the number of nodes). The entries under the type column are:

R -- for real variable (floating point)

I -- for integer variable

C -- for complex variable

L -- for logical variable

H -- for Hollerith word for title or label output

The column named INPUT KEYWORD indicates the input record which provides the initial definition of the variable. RIGID refers to the rigid format input for the ship load file.

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
A	NE	ACOM	R	Cable element diameters.	
AABUOY	100	BUOYS	R	Additional array for future expansion.	
AACAB	100	CABLE	R	Additional array for future expansion.	
AACON	100	CONTRL	R	Additional array for future expansion.	
AADSP	100	DSPCON	R	Additional array for future expansion.	
AAPAY	100	PAYOUT	R	Additional array for future expansion.	
AASHP	100	SHIPS	R	Additional array for future expansion.	
AASTM	100	STRUM	R	Additional array for future expansion.	
AATIM	100	TIMED	R	Additional array for future expansion.	
ABUOY		TYPES	I	Numeric code for BUOY keyword = 56	
ACCCUR		SHIPS	R	Accumulated surface current load factor for DEAD/LIVE.	
ACCFAC		CONTRL	R	Accumulated load factor for DEAD/LIVE.	
ACCWND		SHIPS	R	Accumulated wind load factor for DEAD/LIVE.	
ACONF		TYPES	I	Numeric code for CONF, keyword = 57.	
ADM	50	BUOYS	R	Buoyant forces for BODY table.	BODY
AHEAD		TYPES	I	Numeric code for HEAD keyword = 51.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
AIMPA		TYPES	I	Numeric code for IMPA keyword = 31.	
AINIT		TYPES	I	Numeric code for INIT keyword = 32.	
AINVE		TYPES	I	Numeric code for INVE keyword = 18.	
ALIMI		TYPES	I	Numeric code for LIMI keyword = 19.	
ALINE		TYPES	I	Numeric code for LINE keyword = 20.	
ALIVE		TYPES	I	Numeric code for LIVE keyword = 2.	
ALLOC		TYPES	I	Numeric code for LLOC keyword = 21	
ALOAD		TYPES	I	Numeric code for LOAD keyword = 34.	
ALPNEW		TIMED	R	Generalized Newmark integration parameter.	TIME
ALVAR		TYPES	I	Numeric code for LVAR keyword = 35.	
AMATE		TYPES	I	Numeric code for MATE keyword = 22.	
AMAX		CDCAL	R	Strum string response parameter.	
AMAXL	5	PAYOUT	R	Mitosis lengths for payout elements.	PAYO
AMODE		TYPES	I	Numeric code for MODE keyword = 5.	
AMOVE		TYPES	I	Numeric code for MOVE keyword = 36.	
AMPMN		FRQDAT	R	Cut off wave amplitude for FREQ SAO.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
AMSOL		TYPES	I	Numeric code for MSOL keyword = 37.	
ANCH		TYPES	I	Numeric code for ANCH keyword = 55.	
ANCTAB	5,16,6	COMPNT	R	Inventory anchor property table.	
ANEW		TYPES	I	Numeric code for NEW keyword = 9.	
ANODE		TYPES	I	Numeric code for NODE keyword = 23.	
APROP	3	SHIPS	R	Propeller projected area.	SHIP
ASHIP		TYPES	I	Numeric code for SHIP keyword = 24.	
ASTEP		TYPES	I	Numeric code for STEP keyword = 43.	
ASTRUM		TYPES	I	Numeric code for STRU keyword = 25.	
ATIME		TYPES	I	Numeric code for TIME keyword = 45.	
ATYPE	3,6	COMPNT	R	Inventory anchor type table.	
AWIND		TYPES	I	Numeric code for WIND keyword = 46.	
BAM	30	FRQDAT	R	List wavelength from ship motion file.	
BAMC	50	BUOYS	R	Added mass coefficients for body table.	BODY
BETNEW		TIMED	R	Integration parameter, β.	TIME
BLEN	50	BUOYS	R	Length for cylindrical buoys, body table.	BODY
BLOC		TYPES	I	Numeric code for BLOC keyword = 13.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
BLOCK	3	SHIPS	R	Block coefficient for each ship.	
BMOM	50	BUOYS	R	Mass moment of inertia for body table.	BODY
BODY		TYPES	I	Numeric code for BODY keyword = 14.	
BOMAS	50	BUOYS	R	Body mass for body table.	
BOVOL	50	BUOYS	R	Body volume for body table.	
BSCD	50	BUOYS	R	Surface current drag for body table.	BODY
BTYPE	3,2	COMPNT	R	Inventory buoy type table.	
BUOKP	3,50	BUOYS	R	Body location parameters for checking static response instability.	
BUOTAB	7,6,2	COMPNT	R	Inventory buoy property table.	
BWND	50	BUOYS	R	Wind drag coefficients for surface buoy.	BODY
B44S	8	FRQDAT	R	Roll damping terms for ship motion file.	
CABMAS	10	CABLE	R	Mass per unit length for cable materials.	
CAD		SHIPS	R	Global current heading in degrees.	SURF
CAMC	10	CABLE	R	Line material added mass coefficient.	MATE
CBUO		BUOYS	R	Body drag coefficient.	
CEPS		STRUM	R	Strum update parameter.	SOLU
CHAIN	31,3	COMPNT	R	Inventory chain property table.	
CHECKR		LOGIC	L	Component check flag; True means CHEK SAO active.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
CHEK		TYPES	I	Numeric code for CHECK key-word = 7.	
CLBL		SHPLBL	H	Current load label for ship-load file.	RIGID
CORDLM	50	BUOYS	R	Limit set coordinate for limit table.	LIMI
CPROP	3	SHIPS	R	Propeller resistance coefficient.	SHIP
CR	3	SHIPS	R	Longitudinal resistance coefficient.	SHIP
CRST	30	STRUM	R	Not used at present.	
CS	3	SHIPS	R	Hull wetted surface coefficient.	SHIP
CURCOE	20,3,5	SHIPS	R	Current load coefficient for ship load tables.	RIGID
CURHED	20	SHIPS	R	Current headings for ship load tables.	RIGID
CURLEN	5	PAYOUT	R	Current length of payout element.	
CURMUL		CABLE	R	Flow field scale factor.	CURR
CURNT		SHIPS	R	Magnitude of surface current.	SURF
CURR		TYPES	I	Numeric code for CURR key-word = 28.	
CYLRMS	50	BUOYS	R	Added mass for cylindrical buoy in body table.	
DA	6,6	FRQDAT	R	Ship's added mass matrix from ship motion file.	
DALPHA		TIMED	R	Proportional damping multi-plier of mass matrix or alpha integration parameter for VRS/VRR solutions.	SOLU

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
DB	6,6	FRQDAT	R	Ship's damping matrix from ship motion file.	
DBETA		TIMED	R	Proportional damping multiplier of stiffness matrix or initial pseudo-time step for VRS/VRR solutions.	SOLU
DBU	50	BUOYS		Body diameters for body table.	BODY
DC	6,6	FRQDAT	R	Ship's restoring force matrix from ship motion file.	
DEAD		TYPES	I	Numeric code for DEAD keyword = 1.	
DELFAC		CONTRL	R	Load factor increment (step size) for DEAD/LIVE.	
DELTMP		CONTRL	R	Temporary storage for DELFAC for VRS/VRR solutions.	
DERAD		CONTRL	R	Degree/radian conversion factor.	
DERR		CONTRL	R	Displacement error tolerance for iterative solutions.	SOLU
DIAM	10	CABLE		Line material diameters.	MATE
DISPC	30	DSPCON	R	Static imposed displacement amplitudes in C.	MOVE
DISPP	30	DSPCON	R	Reference imposed displacement amplitudes.	
DLD		LOGIC	L	Dead load flag; True means DEAD SAO.	
DLREF		PAYOUT	R	Unstretched lengths for payout elements.	
DMAXAB		TIMED	R	Magnitude of maximum acceleration increment in DYN SAO.	
DMAXP		TIMED	R	Previous maximum acceleration in DYN SAO.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
DMU		CONTRL	R	Numerical damping coefficient.	SOLU
DOMG		FRQDAT	R	Wave frequency increment	SPEC
DONE		TYPES	I	Numeric code for DONE keyword = 54.	
DPTMF	5	PAYOUT	R	Time function increment for payout point.	
DRAD		SHIPS	R	Degrees per radian.	
DRFTFR	3	FRQDAT	R	Wave-induced drift force components.	
DRGAMP	NE	ACOM	R	Drag amplification factor.	
DS	NE	ACOM	R	Current lengths for elements.	
DSO	NE	ACOM	R	Initial lengths for elements.	ELEM
DSR	NE	ACOM	R	Reference lengths for elements.	
DT		TIMED	R	Time step.	TIME
DTH		TIMED	R	Upper bound on time step.	
DTL		TIMED	R	Lower bound on time step.	
DTLL		TIMED	R	Lower bound on time step in DYN SAO.	
DTMAX		TIMED	R	Upper bound on time step in DYN SAO.	
DTRSRT		TIMED	R	Restart save time interval.	SAVE
DTU		TIMED	R	Reference update time.	TIME
DU	NE	ACOM	R		
DYN		LOGIC	L	Transient dynamic flag; True means DYN SAO.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
E	2,10	CABLE	R	Slopes of line segments in material tables.	
ELEM		TYPES	I	Numeric code for ELEM keyword = 15.	
ELL		FRQDAT	R	Ship's length for nondimensionalized ship motion file.	
ERR		ERR	R	Not used.	
ES	NE	ACOM	R	Element secant EA in ${}^{t}C$.	
ESP	2,5	PAYOUT	R	Multimaterial payout secant modulii.	
ET	NE	ACOM	R	Element tangent EA in ${}^{t}C$.	
EXTE		TYPES	I	Numeric code for EXTE keyword = 49.	
EXTRAP		CONTRL	R	MNR extrapolation factor.	
F	NN3	ACOM	R	Nodal loads in ${}^{t}C$.	
FACH		SHIPS	R	Depth correction factor.	
FACLEN		FRQDAT	R	Length conversion factor for ship motion file.	EXTE
FBUSK	50	BUOYS	R	Surface buoy time function value for body locations.	
FDEPTH	5	CABLE	R	Fluid interface depths.	FLUI
FDIVY		CONTRL	R	Inventory conversion factor for line diameters.	INVE
FEEDBK		LOGIC	L	Feedback flag; True means feedback form used, RFB or VRR.	
FELT	3,2	CHKDAT	R	Fluid loads on a single element for CHEK SAO.	
FG	NN3	ACOM	R	Nodal point gravity loads.	
FGAM	5	CABLE	R	Fluid table specific weights.	FLUI

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
FINC		CONTRL	R	Alters the residual added mass correction for TL or UL solutions.	
FINIS		TYPES	I	Numeric code for END keyword = 10.	
FIX		TYPES	I	Numeric code for FIX keyword = 29.	
FLNVY		CONTRL	R	Inventory conversion factor for buoy diameters and lengths.	INVE
FLOW		TYPES	I	Numeric code for Flow keyword = 16.	
FLPAR	10,10	CABLE	R	Flow field table parameters	FLOW
FLUI		TYPES	I	Numeric code for FLUI keyword = 17.	
FP	3,NN3	ACOM	R	Point loads for load sets.	LOAD
FRCFAC		FRQDAT	R	Force conversion factor for ship motion file.	EXTE
FRCVY		CONTRL	R	Inventory conversion factor for weights and strengths.	INVE
FREE		TYPES	I	Numeric code for FREE keyword = 30.	
FREQ		TYPES	I	Numeric code for FREQ keyword = 6.	
FSFRC	3	SHIPS	R	Ship load table conversion factor for current force.	SHIP
FSFRW	3	SHIPS	R	Ship load table conversion for wind force.	SHIP
FSLEN	3	SHIPS	R	Ship load table conversion factor for length.	SHIP
FSOL		TYPES	I	Numeric code for FSOL keyword = 47.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
FSVEL	3	SHIPS	R	Ship load table conversion for velocity.	SHIP
FTF	3	TIMED	R	Time function values for load sets in ^{t}C.	
FTI	15	TIMED	R	Time function values for dynamic moving boudary components in ^{t}C.	
FVISC	5	CABLE	R	Fluid table kinematic viscosities.	FLUI
F1	NN3	ACOM	R	Nodal point loads from current and wind in ^{t}C.	
F2	NN3	ACOM	R	Total nodal point loads at the incremental reference state. Also used for iterative displacement increment in NRAPIT subroutine.	
GAIR		SHIPS	R	Specific weight of air.	
GAMNEW		TIMED	R	Gamma integration parameter.	TIME
GHED		FRQDAT	R	Global wave heading in degrees.	HEAD
GK	NF3,IBEND	ACOM	R	Global incremental stiffness matrix stored in banded row form.	
GKS	3,3	SHIPS	R	Element stiffness matrix for strum string.	
GM	NN3	ACOM	R	Diagonal mass matrix including residual added mass.	
GMA	NE	ACOM	R	Residual added mass for each element.	
GMU	6,6	FRQDAT	R	Ship's mass matrix from ship motion file.	
GRAV		CONTRL	R	Acceleration due to gravity.	PROB
G1		CONTRL	R	Kinematic viscosity of first fluid, water.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
G2		CONTRL	R	Specific weight of first fluid, water.	
G3	10	CABLE	R	Weight per unit length of line material.	MATE
HAWSIZ	23	COMPNT	R	Inventory hawser sizes.	
HAWTAB	2,23,4	COMPNT	R	Inventory hawser property table.	
HDG1	30	FRQDAT	R	Wave headings for ship motion file.	
HEAD	3	SHIPS	R	Ship's global heading.	
HED	20	HEDCHR	H	Page heading title.	
HEDEND		SHIPS	R	Surface load total heading change.	STEP
HEDMAX		SHIPS	R	Upper bound on heading increment.	
HEDINC		SHIPS	R	Surface load heading increment.	STEP
HEDNOW		SHIPS	R	Surface load heading value in °C.	
HIRSDL		DSPCON	R	VRR control parameter; keeps tract of largest residual found.	
HLDFAC	6	COMPNT	R	Inventory anchor holding factor table.	
HTYPE	3,4	COMPNT	R	Inventory hawser types.	
IAABU	10	IBUOYS	I	Additional array for future expansion.	
IAACA	10	ICABLE	I	Additional array for future expansion.	
IAACL	10	ICNTRL	I	Additional array for future expansion.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
IAADS	10	IDSPCN	I	Additional array for future expansion.	
IAAPO	10	IPAYOT	I	Additional array for future expansion.	
IAASHP	10	ISHIPS	I	Additional array for future expansion.	
IAASTM	10	ISTRUM	I	Additional array for future expansion.	
IAATIM	10	ITIMED	I	Additional array for future expansion.	
IALTR		ITIMED	I	Alternating acceleration increment flag for DYN SAO.	
IB	5	ITIMED	I	List of dynamic moving boundary nodes.	
IBEND		ICNTRL	I	Half bandwidth.	
IBEND1		ICNTRL	I	Half bandwidth with incremental moving boundary.	
IBEND2		ICNTRL	I	Half bandwidth without incremental moving boundary.	
IBG		ICNTRL	I	Debug output flag	OUTP
IBGF		FRQDAT	I	Debug output flag for FRQ SAO.	RESU
IBS	50	IBUOYS	I	Time variation codes for surface buoys.	SBUO
IBU	50	IBUOYS	I	Nodes where bodies are located.	BLOC
ICMCHF		FRQDAT	I	Component check file flag.	FSOL
ICONMS		FRQDAT	I	Mass matrix format code.	FSOL
ICR		ISHIPS	I	Flag to signal if table lookup is used to get hull resistance factor.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
IDAMPR		ICABLE	I	Material damping flag; 0 means no damping.	
IDAY		HEDCHR	H	Character string for date.	
IDIR		ICNTRL	I	Coordinate number for vertical direction.	
IDIS	30,3	IDSPCN	I	Static displacement variation codes.	
IDRB	50	IBUOYS	I	Drag coefficient codes for bodies.	BODY
IDRG	10	ICABLE	I	Drag coefficient codes for line materials.	MATE
IDRITR		FRQDAT	I	Drift force iteration flag.	FSOL
IDWN		IDSPCN	I	VRS/VRR control parameters; signals successive reductions of velocity norm.	
IFCNT		ICNTRL	I	Record counter for frequency domain CHEK data.	
IFILE	4	SIZE	I	Restart file record counters.	
IFLAGS	60	IFLAG	H	Codes for each of the keywords, 4 characters each.	
IFLCOD	10	ICABLE	I	Flow field codes.	FLOW
IFREQ		ISHIPS	I	Signals the frequency domain solution to the stiffness matrix routines.	
IFRQUP		FRQDAT	I	Iteration option for drift force updates.	FSOL
IFXFL		ICNTRL	I	Limit condition flag used to signal constraint code changes.	
IGK		ICNTRL	I	Solution format code for stiffness matrix.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
IKEEP		TYPES	I	Numeric code for KEEP keyword = 33.	
IKNSTN		ICNTRL	I	Limit check over-ride flag.	
ILF	3	ITIMED	I	Load set variation codes.	LVAR
IMPBOD		IBUOYS	I	Body number for body impact.	IMPA
IMPNOD		IBUOYS	I	Node number for body impact.	IMPA
IMTMF	15	ITIMED	I	Moving boundary variation codes.	MOVE
IMX		ITIMED	I	Number degree of freedom with largest acceleration increment for DYN SAO.	
INC		ICNTRL	I	Solution increment counter.	
INDRAG		ICNTRL	I	Drag model override flag.	PROB
INVFLG		CHKDAT	I	Inventory useage flag.	
INVP		IDSPCN	I	VRS/VRR control parameter.	
INVY		ICNTRL	I	Inventory useage flag.	
IOPT		IBUOYS	I	Impacting body weight option code.	IMPA
IPAGE		HEDDAT	I	Page counter.	
IPR		ICNTRL	I	Number of steps between printouts.	OUTP
IROLIT		FRQDAT	I	Roll damping iteration flag.	FSOL
IRR			I	Error return flag; ≠0 means error.	
IRST		RETAPE	I	Restart file flag.	SAVE or REST
ISHIP	3	ISHIPS	I	Nodes where ships are located.	SHIP

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
ISHPFL		FRQDAT	I	Ship flag for FREQ SAO; 0 means no ship.	
ISHTAP		ISHIPS	I	Flag to signal the use of ship load file.	
ISIGN1		ITIMED	I	Alternating response estimates flag for DYN SAO.	
ISIGN2		ITIMED	I	Alternating response estimates flag for DYN SAO.	
IST		CDCAL	I	Strum string number.	
ISTART		ICNTRL	I	Solution option code; see NSLOP.	
ISTRNG	30	ISTRUM	I	Number of elements in each strum string.	STRU
ISTRUP		ISTRUM	I	Strum update flag.	
ISURLD		ISHIPS	I	Wind and surface current load flag.	
IT	2,NE	ACOM	I	Element connectivity list.	ELEM
ITCONF		FRQDAT	I	Counter for drift force iterations.	
ITFCOD	20	ITIMED	I	Time function type code.	TFUN
ITIME		HEDCHR	H	Character string for time.	
ITOP		ITIMED	I	Upper bound flag on time step in DYN SAO.	
ITUP		IDSPCN	I	VRS/VRR solution parameter.	
IUNRES		FRQDAT	I	Unrestrained motion output flag.	RESU
IUP		ISHIPS	I	Code for up direction.	
IUPDT		ICNTRL	I	Counter for configuration updates.	
JANCR	50	IBUOYS	I	Limit set fixity codes.	LIMI

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
JB	15	ITIMED	I	Moved component variation codes.	MOVE
JDLD		ICNTRL	I	Dead load option flag	LVAR
JDYN		ICNTRL	I	Dynamic solution option flag.	PROB
JMPDT		ICNTRL	I	Step size control number.	SOLU
JOP	5	IPAYOT	I	Node numbers for payout points.	PAYO
JOVR		ICNTRL	I	Limit set overshoot node.	
JPELT	5	IPAYOT	I	Element numbers for payout.	PAYO
JSLP	2,50	IBUOYS	I	Lists connecting elements for cylindrical buoys or defining nodes for mooring buoys.	
JSTEPR		IDSPCN	I	Number of steps.	STEP
KNSTRN		IBUOYS	I	Flag to signal if limit locations are defined.	
KNTEST		ITIMED	I	Counter for restart save intervals.	
KODEC	2	ISHIPS	I	Variation codes for surface current.	SURF
KODEW	2	ISHIPS	I	Variation codes for wind loads.	WIND
KOMP	NE	ACOM	I	Element type code.	ELEM
KONECT	10,50	IBUOYS	I	Lists elements connecting to each limit location.	
KONVRT		ICNTRL	I	Number of iteration trials.	SOLU
KOUNT		ICNTRL	I	Solution iteration counter.	
KSTRNG	20,30	ISTRUM	I	Lists strum string elements up to 20 per string.	STRU

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
KUP		ICNTRL	I	Time step increase control parameter in DYN SAO.	
LBODN	50	IBUOYS	I	List of body numbers of body locations.	BLOC
LIMNOD	50	IBUOYS	I	List of limit location nodes.	LLOC
LIMSET	50	IBUOYS	I	List of limit set numbers for limit locations.	LLOC
LLBL		SHPLBL	H	Length label for ship load file.	RIGID
LMITER		ICNTRL	I	Maximum number of iterations per step.	SOLU
LMKEEP		IDSPCN	I	Temporary storage of LMITER for VRS/VRR solutions.	
LSHP	3	ISHIPS	I	Ship load function codes.	SHIP
MAT	NE	ACOM	I	List of element material numbers.	ELEM
MATDMP	10	ICABLE	I	List of material damping flags; 0 means this material has no damping.	
MATT		ICABLE	I	Number of materials defined.	
MBLN	50	IBUOYS	I	Counters for number of number slave nodes on mooring buoys.	
ME	10	ICABLE	I	Number of points in each material table.	MATE
MED	10	ICABLE	I	List of medium codes for material tables.	MATE
MEDIUM	NE	ACOM	I	Fluid medium codes for elements.	ELEM
MEDMB	50	IBUOYS	I	List of medium codes for body table.	BODY

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
MITNOT		IPAYOT	I	Mitosis prevention flag.	
MNOB		FRQDAT	I	Maximum number of wave speeds on ship motion file.	
MNOH		FRQDAT	I	Maximum number of wave headings on ship motion file.	
MNOK		FRQDAT	I	Maximum number of wave lengths on ship motion file.	
MNRV		FRQDAT	I	Maximum number of roll angles on ship motion file.	
MODEI1		ICNTRL	I	Mode shape order flag.	MSOL
MODEI2		ICNTRL	I	Mode shape output flag.	MSOL
MORBUO		IBUOYS	I	Number of mooring buoys.	
MOSTAT		ICNTRL	I	TSSS flag; 1 - yes, o - no.	
MULMAT	5	IPAYOT	I	Multimaterial flag for payout element.	
MULTIM		IPAYOT	I	Multimaterial payout flag.	
MVB		ICNTRL	I	Number of nodes with defined motion in DYN SAO.	
MVBINC		ICNTRL	I	Number of incremental moving boundary nodes.	
MXBLOC		IBUOYS	I	Maximum number of body locations.	
MXBODY		IBUOYS	I	Maximum number of bodies in table.	
MXFLOW		ICABLE	I	Maximum number of flow tables.	
MXLIMS		IBUOYS	I	Maximum number of limit sets.	
MXLINE		HEDDAT	I	Number of lines per page.	
MXLLOC		IBUOYS	I	Maximum number of limit locations.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
MXSELT		ISTRUM	I	Maximum number of element per strum string.	
MXSHIP		ISHIPS	I	Maximum number of ship locations.	
MXSTRG		ISTRUM	I	Maximum number of strum strings.	
MXTFUN		ITIMED	I	Maximum number of time functions.	
NANCR	6	COMPNT	I	Inventory anchor count.	
NBASE		ICNTRL	I	Number of entries in the base portion of ACOM.	
NBLOC		IBUOYS	I	Number of body locations.	
NBUOY	2	COMPNT	I	Inventory buoy count.	
NCHN		COMPNT	I	Inventory chain count.	
NCOM		SIZE	I	Size of ACOM.	
NCONC		ICNTRL	I	Number of concentrated loads (point loads).	
NCRNT		ISHIPS	I	Number of current tables in ship load file.	
NCYLB		IBUOYS	I	Number of cylindrical buoys.	
NDISP		IDSPCN	I	Number of static imposed displacement.	
NDROP		IDSPCN	I	VRS/VRR control parameter; counts down for 3 velocity convergence trials with damping reduced.	
NE		ICNTRL	I	Number of cable/line elements.	
NELCK		CHKDAT	I	Element number being checked.	
NELPO1	5	IPAYOT	I	Element number increment for payout.	PAYO

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
NEWCON		FRQDAT	I	New configuration flag for drift force updates.	
NEWRED		FRQDAT	I	Global heading input flag for FREQ SAO.	
NFILE		RETAPE	I	Restart file code	REST
NFILEF		FRQDAT	I	Ship motion file format flag.	EXTE
NFIX		ICNTRL	I	Number of globally fixed nodes (always 0).	
NFKEEP	30	IDSPCN	I	Previous nodes component fixity codes for static imposed displacement and moving boundary.	
NFLUI		ICABLE	I	Number of fluids defined.	
NFLVRY		ICABLE	I	Flow field variation code	CURR
NFLUID		ICNTRL	I	Flow field number	CURR
NFN		ICNTRL	I	Number of active nodes.	
NF3		ICNTRL	I	Number of active degrees of freedom.	
NFREQS		FRQDAT	I	Counter for the number of frequencies in FREQ SAO.	
NGROW	5	IPAYOT	I	Number of elements available for payout.	PAYO
NHAWS	4	COMPNT	I	Inventory hawser count.	
NHED		HEDDAT	I	Number of words in page heading; defined in SEADYN.	
NIN		TAPES	I	Input file code.	
NINA		SIZE	I	Number of words in /ACOM/.	
NINB		SIZE	I	Number of words in /BUOYS/.	
NINBI		SIZE	I	Number of words in /IBUOYS/.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
NINC		SIZE	I	Number of words in /CABLE/.	
NINCI		SIZE	I	Number of words in /ICABLE/.	
NINCLI		SIZE	I	Number of words in /ICNTRL/.	
NINDSI		SIZE	I	Number of words in /IDSPCN/.	
NINDSP		SIZE	I	Number of words in /DSPCON/.	
NINPO		SIZE	I	Number of words in /PAYOUT/.	
NINPOI		SIZE	I	Number of words in /IPAYOT/.	
NINRL		SIZE	I	Number of words in /CONTRL/.	
NINSHI		SIZE	I	Number of words in /ISHIPS/.	
NINSHP		SIZE	I	Number of words in /SHIPS/.	
NINSTI		SIZE	I	Number of words in /ISTRUM/.	
NINSTM		SIZE	I	Number of words in /STRUM/.	
NINT		SIZE	I	Number of words in /TIMED/.	
NINTMI		SIZE	I	Number of words in /ITIMED/.	
NIXPRN		ITIMED	I	Print override flag for restart.	SAVE
NLIMS		IBUOYS	I	Number of limit sets.	
NLINES		HEDDAT	I	Output lines counter.	
NLLOC		IBUOYS	I	Number of limit locations.	
NMOTN	50	IBUOYS	I	Buoy on surface motion code.	SBUO
NN		ICNTRL	I	Total number of nodes.	
NNPOI	5	IPAYOT	I	Not used at present	
NN3		ICNTRL	I	Three times NN.	
NOB		FRQDAT	I	Number of wave speeds on ship motion file.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
NODFIX	NN3 *	ACOM	I	Node component fixity flags.	
NODWN		IDSPCN	I	VRS/VRR control parameter.	
NOFLUD		LOGIC	L	Fluid medium flag; True means no fluids.	
NOH		FRQDAT	I	Number of wave headings on ship motion file.	
NOITER		LOGIC	L	Iteration flag; T means not iterative solution.	
NOK		FRQDAT	I	Number of wavelengths on ship motion file.	
NOLINE		HEDDAT	I	Number of lines is standard output record.	
NOLOAD		LOGIC	L	Point load flag; True means no point loads.	
NOP		IPAYOT	I	Number of payout ends.	
NOUT		TAPES	I	Output file number.	
NOVEL		LOGIC	L	Flow field flag; True means no fluid velocities.	
NPOVRY	5	IPAYOT	I	Payout time variation codes.	PAYO
NPRECZ		SIZE	I	Precision of floating point words; 1 - single, 2 - double.	
NPRST		ICNTRL	I	Preload flag.	
NRUP		ICNTRL	I	Newton-Raphson update code.	SOLU
NRV		FRQDAT	I	Number of roll angles on ship motion file.	
NSFILE		ISHIPS	I	Ship load file flag.	PROB
NSHIPS		ISHIPS	I	Number of ships.	
NSHRNK	5	IPAYOT	I	Number of elements available for reel-in	PAYO

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
NSLAVE		ICNTRL	I	Number of slave nodes.	
NSLOP		IDSPCN	I	Solution option number code; 0 - MNR, 1 - SLI, 2 - RFB, 3 - VRS/VRR, 5 - DIM.	
NSOLN		FRQDAT	I	Counter for FREQ wave heading solutions.	
NSRDC		FRQDAT	I	File code for ship motion file = 8.	
NSTRNG		ISTRUM	I	Number of strum strings.	
NSTRUP		ISTRUM	I	Strum update flag.	
NSTUP		ICNTRL	I	First step subdivision startup parameter.	STEP
NS3		FRQDAT	I	Three times (NN-NSLAVES).	
NTAPE		RETAPE	I	File code for restart input tape.	REST
NTAPE1		TAPES	I	File code for binary translation of free-field input = 15.	
NTAPE2		TAPES	I	File code for rigid format input = 16.	
NTAPE9		TAPES	I	File code for file code 09, scratch file.	
NTHETC		ISHIPS	I	Number of current headings in ship load tables.	RIGID
NTHETW		ISHIPS	I	Number of wind headings in ship load tables.	RIGID
NTPCHK		TAPES	I	File code for wave heading file for CHEK = 13.	
NTYPE		ICNTRL	I	Numeric code for current SAO keyword.	
NUMHED		ISHIPS	I	Counter for the number of headings evaluated in static heading excursion.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
NUMSET		ICNTRL	I	Number of load sets defined.	
NUP		ICNTRL	I	Configuration update flag	SOLU
NWIND		SHIPS	I	Number of wind velocity tables on ship load file.	RIGID
NWORDS		HEDDAT	I	Number of words in working area for input.	
NXTYPE		ICNTRL	I	Numberic code for the next SAO keyword.	
OMG		CDCAL	R	Strum string natural frequency.	
OMG		FRQDAT	R	Spectrum frequency for FREQ SAO.	
OMGMN		FRQDAT	R	Lower bound of spectrum frequency scan	SPEC
OMGMX		FRQDAT	R	Upper bound of spectrum frequency scan.	SPEC
OMS		CDCAL	R	Strum string Strouhal frequency.	
OM2		FRQDAT	R	Square of OMG for FRQ SAO.	
OUTP		TYPES	I	Numeric code for OUTP keyword = 38.	
OVRSHT		CONTRL	R	Limit condition overshoot.	
PARMT		CONTRL	R	MNR extrapolation parameter.	SOLU
PAYO		TYPES	I	Numeric code for PAYO keyword = 39.	
PAYV	5	PAYOUT	R	Payout velocity	PAYO
PI		CONTRL	R	PI = 3.1415......	
PINC		CONTRL	R	Output interval increment.	
PLOT		TYPES	I	Numeric code for PLOT keyword = 8, inactive.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
POUT		LOGIC	L	Payout flag; True means payout active.	
PROB		TYPES	I	Numeric code for PROB keyword = 11.	
PROPF	3	SHIPS	R	Propeller force coefficients.	
PSTEP		CONTRL	R	Output load level.	
PTMF	5	PAYOUT	R	Values of payout time variation functions.	PAYO
QST	20	STRUM	R	Strum string mode shape.	
RAND		TYPES	I	Numeric code for RAND keyword = 52.	
RANG	8	FRQDAT		Roll angles for ship motion file.	
RATD		CONTRL	R	Initial size of static load increment.	
RATL	3	SHIPS	R	Length ratios for ship's current load scaling.	
REFUP		LOGIC	L	Geometric reference update flag.	
REGU		TYPES	I	Numeric code for REGU keyword = 53.	
RELFAC	50	BUOYS	R	Release factor for limit sets.	LIMI
RERR		CONTRL	R	Residual error tolerance.	SOLU
REST		TYPES	I	Numeric code for REST keyword = 12.	
RESU		TYPES	I	Numeric code for RESU keyword = 50.	
RNORM		DSPCON	R	Residual norm.	
RNORMP		DSPCON	R	Preceding residual norm.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
RNRMPP		DSPCON	R	Second preceding residual norm.	
RTIN		CDCAL	R	Strum string modal scaling factor.	
RVELN		STRUM	R	Relative velocity magnitude for strum computation.	
RVELNP		STRUM	R	Previous relative velocity magnitude for strum computation.	
SAE	3	SHIPS	R	Ship end projected areas.	SHIP
SAS	3	SHIPS	R	Ship side project areas.	SHIP
SAVE		TYPES	I	Numeric code for SAVE keyword = 40.	
SBAMP	50	BUOYS	R	Surface buoy motion amplitudes.	SBUO
SBEAM	3	SHIPS	R	Ship beams amidships.	SHIP
SBUO		TYPES	I	Numeric code for SBUO keyword = 41.	
SCALE		SHPTAP	R	Scale factor for ship load file.	RIGID
SDRFT	3	SHIPS	R	Ship drafts amidships.	SHIP
SDSPV	3	SHIPS	R	Ship volume displacements.	SHIP
SFACW	3,3	SHIPS	R	Wind load scale factors for ships.	
SGNOLD		BUOYS	R	Gravity load sign; +1.0 for gravity in + coordinate direction, -1.0 for gravity in - coordinate direction.	
SHPCAP	12	SHPLBL	H	Title for ship load file.	RIGID
SHIPK	4,3	SHIPS	R	Ship's hydrostatic restoring coefficients.	SHIP

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
SHPKP	3,3	SHIPS	R	Ship response parameters for checking static response stability.	
SHTRN	3,3,3	SHIPS	R	Local to global transformation matrices for each ship.	
SIG	NE	ACOM	R	Element tensions in ${}^{t}C$.	ELEM or TENS
SIGR	NE	ACOM	R	Element tensions in ${}^{R}C$.	
SLT	3	SHIPS	R	Ship lengths.	SHIP
SLWL	3	SHIPS	R	Ship water line lengths.	SHIP
SOLU		TYPES	I	Numeric code for SOLU keyword = 42.	
SPEC		TYPES	I	Numeric code for SPEC keyword = 48.	
SPECA		FRQDAT	R	Wave spectrum coefficient, A.	SPEC
SPECB		FRQDAT	R	Wave spectrum coefficient, B.	SPEC
SRCHFC		CONTRL	R	Search factor for ID search accelerator on MNR solution.	SOLU
SSTART		CONTRL	R	First step subdivision parameter.	
STEPUP		LOGIC	L	Increment reference update flag.	
STLEN	20	STRUM	R	Strum string lengths.	
STN	NE	ACOM	R	Element strains in ${}^{t}C$.	
ST[illegible]	20,10	CABLE	R	Strain values for material tables.	MATE
SURF		TYPES	I	Numeric code for SURF keyword = 44.	
SURFCE		SHIPS	R	Vertical coordinate at the water surface, determined by the initial vertical position of the last ship input. Used only when ship restoring coefficients are input.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
T		TIMED	R	Time.	
TBLOCK		SHPTAP	R	Test Ship block coefficient for ship load file.	
TDEPTH		SHPTAP	R	Test depth for ship load file.	
TEMP	6,6	FRQDAT	R	Temporary storage array for FREQ SAO.	
TENS		TYPES	I	Numeric code for TENS keyword = 26.	
TENULT	50	CALBE	R	Line material ultimate tensions.	MATE
TFSAV	5	PAYOUT	R	Temporary storage of payout time functions.	
TFUN		TYPES	I	Numeric code for TFUN keyword = 27.	
TN	3,NE	ACOM	R	Direction cosines for each element in ^{L}C.	
THR	3,NE	ACOM	R	Direction cosines for each element in ^{R}C.	
TIMFAC		FRQDAT	R	Time conversion factor for ship motion file.	EXTE
TMAS		FRQDAT	R	Ship's mass for ship motion file.	
TMAX		TIMED	R	Maximum time.	
TMFRF	3	TIMED	R	Point load time variation functions in ^{R}C.	
TMFRM	15	TIMED	R	Moving boundary time variation functions in ^{R}C.	
TOLIM	50	BUOYS	R	Limit set tolerances.	LIMI
TPARM	20,20	TIMED	R	Time function tables.	TFUN
TRNSTR	3,3,NE	ACOM	R	Local-to-global transformation matrices for each element.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
TRSRT		TIMED	R	Restart save time.	
TSAE		SHPTAP	R	Test ship end projected area for ship load file.	RIGID
TSAP		SHPTAP	R	Test ship propeller projected area for ship load file.	RIGID
TSAS		SHPTAP	R	Test ship size projected area for ship load file.	RIGID
TSAPL	3	SHIPS	R	Test ship propeller projected areas; used for similarity scaling.	
TSB		SHPTAP	R	Test ship beam for ship load file.	RIGID
TSD		SHPTAP	R	Test ship draft for ship load file.	RIGID
TSDSP		SHPTAP	R	Test ship displacement for ship load file.	RIGID
TSLT		SHPTAP	R	Test ship length for ship load file.	RIGID
TSSS		TYPES	I	Numeric code for TSSS keyword = 4.	
TSWL		SHPTAP	R	Test ship waterline length for ship load file.	RIGID
TT	20,10	CABLE	R	Tension values for material tables.	MATE
TTD	10	CABLE	R	Material damping parameter CA_1.	MATE
TTK	10	CABLE	R	Material stiffness parameter EA_1.	MATE
TZ		TIMED	R	Time when incremental reference was established.	
U	NN3	ACOM	R	Nodal displacement increments from incremental reference to ^{t}C.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
UB	15	TIMED	R	Moving boundary motion amplitudes.	MOVE
UBS	30	BUOYS	R	Surface buoy motion amplitudes.	SBUO
UD	NN3	ACOM	R	Nodal point velocities for ^{t}C.	
UDD	NN3	ACOM	R	Nodal point acclerations for ^{t}C.	
UDDP	NN3	ACOM	R	Nodal point accelerations for $^{t-\Delta t}C$.	
UDDS	NNE	ACOM	R	Nodal point accelerations for incremental reference state.	
UDP	NN3	ACOM	R	Nodal point velocities for $^{t-\Delta t}C$.	
UMVB	15,3	PAYOUT	R	Moving boundary motion data for ^{t}C.	
UMVBP	15,3	PAYOUT	R	Moving boundary motion data for $^{t-\Delta t}C$.	
UP	NN3	ACOM	R	Nodal point displacements for $^{t-\Delta t}C$.	
US	NN3	ACOM	R	Nodal point displacements from ^{R}C to incremental reference state.	
VAIR		SHIPS	R	Kinematic viscosity of air.	
VDUM	3	FRQDAT	R	Temporary storage vector for FREQ SAO.	
VF	NN3	ACOM	R	Nodal point components of flow velocity in ^{t}C.	
VIB	3	BUOYS	R	Components of impacting body velocity.	IMPA
VLBL		SHPLBL	H	Velocity label for ship load file.	RIGID

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
VNORMP		DSPCON	R	Preceding velocity norm for VRS/VRR.	
VNPP		DSPCON	R	Second preceding velocity norm.	
VNPPP		DSPCON	R	Third preceding velocity norm.	
VV	NN3	ACOM	R	Nodal point components of relative velocity in ${}^{t}C$.	
WAD		SHIPS	R	Wind heading in degrees	WIND
WAVEL	30	FRQDAT	R	Wavelengths from ship motion file.	
WDEPTH	3	SHIPS	R	Water depth for each ship.	SHIP
WIND		SHIPS	R	Wind velocity	WIND
WLBL		SHPLBL	H	Wind label for ship load file.	RIGID
WLD		LOGIC	L	Live load flag; True means LIVE SAO.	
WINDCOE	20,3,5	SHIPS	R	Wind load coefficients for ship load table.	RIGID
WNDHED	20	SHIPS	R	Wind headings for ship load tables.	RIGID
WNDVEL	5	SHIPS	R	Wind velocities for ship load tables.	RIGID
WORDS	100	HEDDAT	R	Working area for input.	
WVAMP		FRQDAT	R	Wave amplitude for current spectrum interval.	
WVLN		FRQDAT	R	Wave length for current spectrum interval.	
WVSLP		FRQDAT	R	Wave slope for current spectrum interval.	
XC	NN3	ACOM	R	Nodal position coordinates for ${}^{t}C$.	

VARIABLE NAME	ARRAY SIZE	COMMON NAME	TYPE	DESCRIPTION	INPUT KEYWORD
XO	MN3	ACOM	R	Reference nodal coordinates.	
YSAVE		CDCAL	R	Strum string response, Y/D.	

9.0 MACRO-FLOW CHARTS OF THE SUBANALYSES AND SOLUTION OPTIONS

The following charts outline the overall logic of the major solution options in SEADYN. The relationship of the subanalyses is shown in Figure 2.1. The DEAD, LIVE, and TSSS subanalyses are controlled from the STATIC subroutine. Figure 9.1 outlines that logic. The transient dynamics (DYN) is controlled through the TRANS subroutine. That logic is presented in Figure 9.2. Figure 9.3 describes the MODE subanalysis. The FREQ and CHEK subanalyses are presented in Figures 9.4 and 9.5, respectively. The two static solution routines (NRAPIT and STEP) are outlined in Figures 9.6 and 9.7.

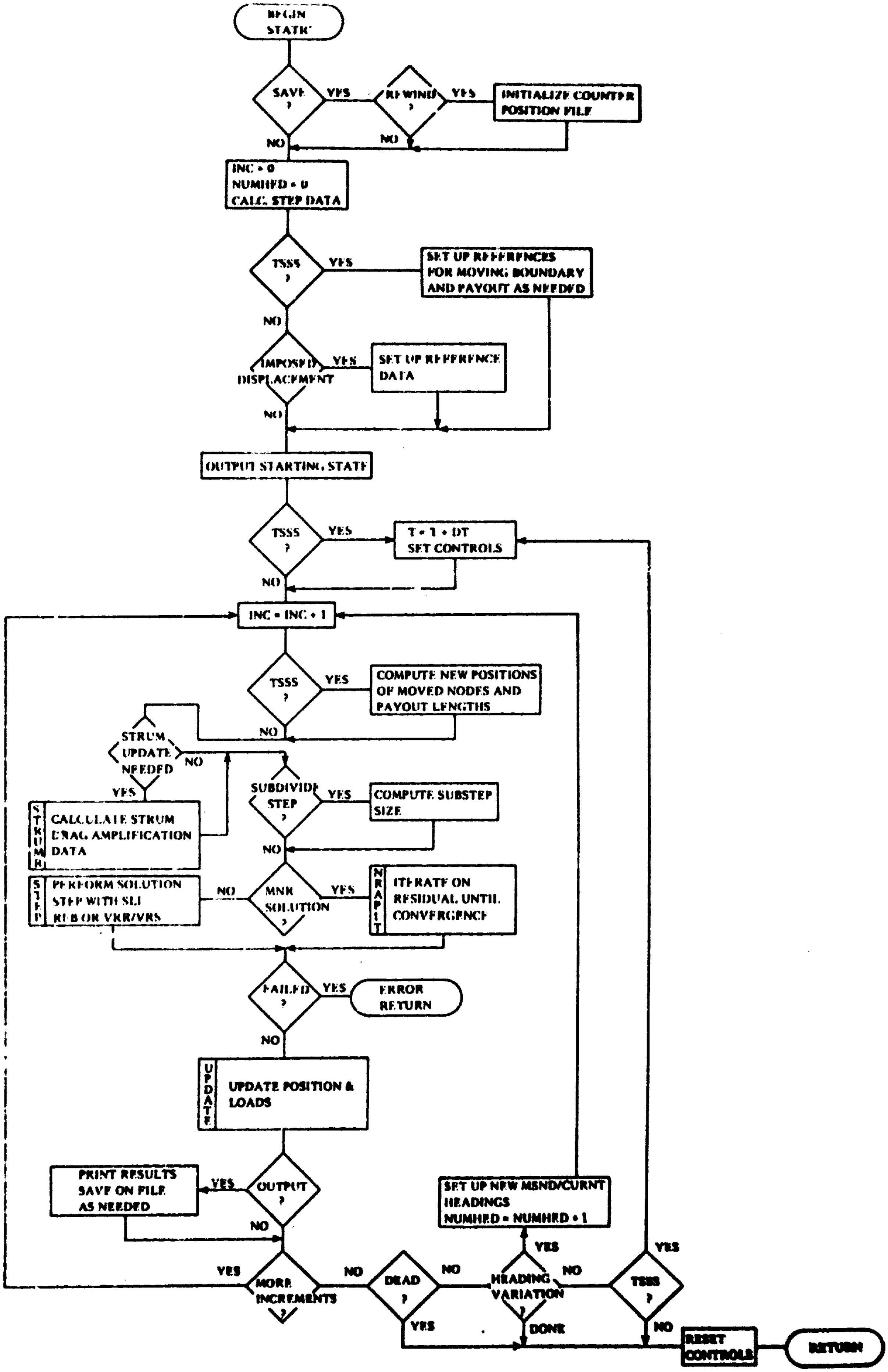


Figure 9.1 Static load options, DEAD/LIVE/TSSS.

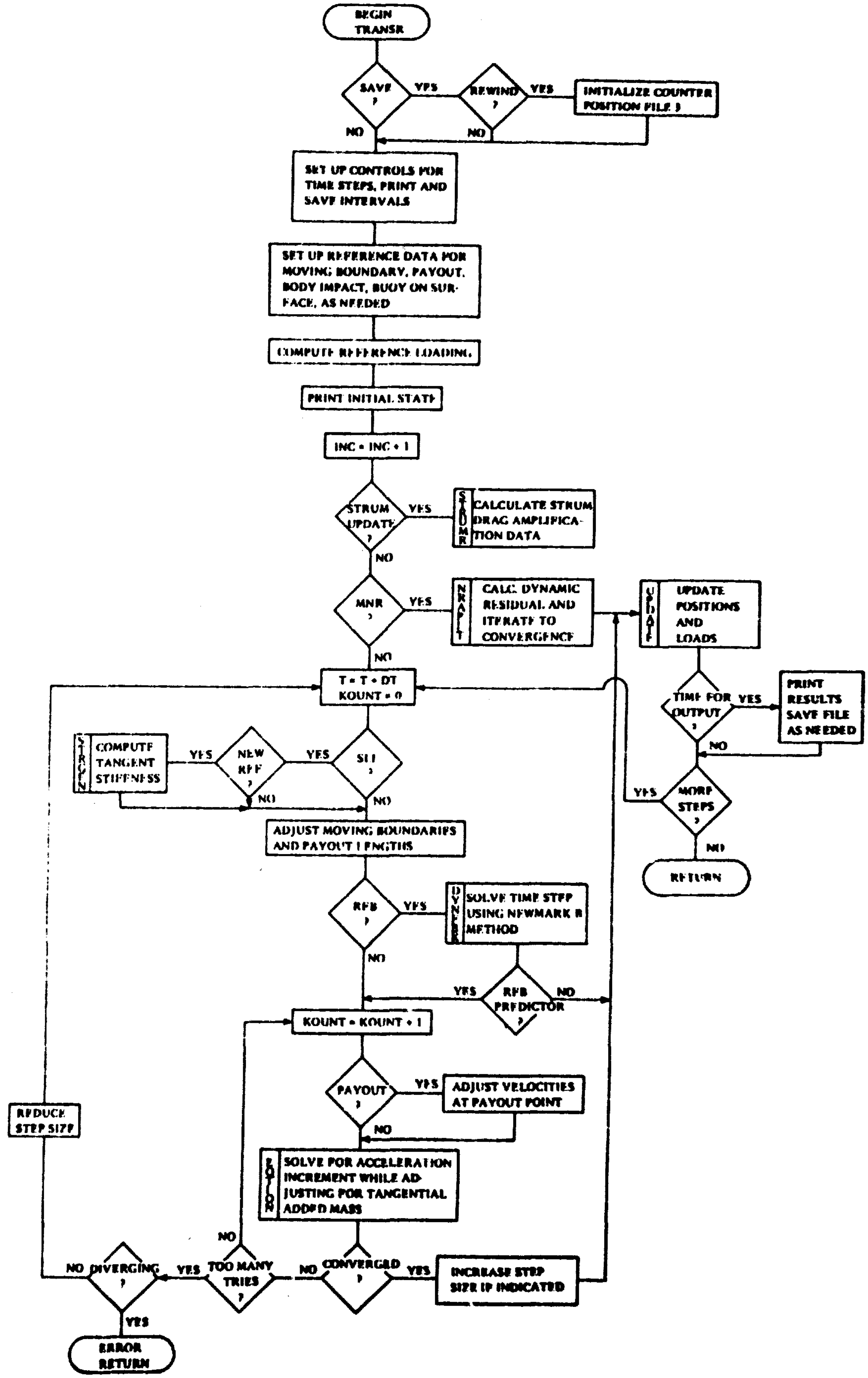


Figure 9.2 Transient response option, DYN.

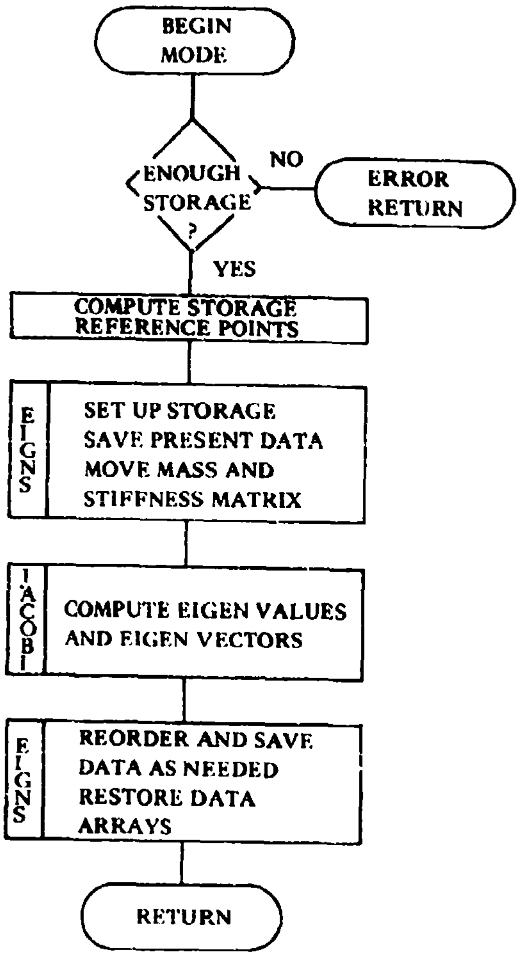


Figure 9.3 Mode subanalysis.

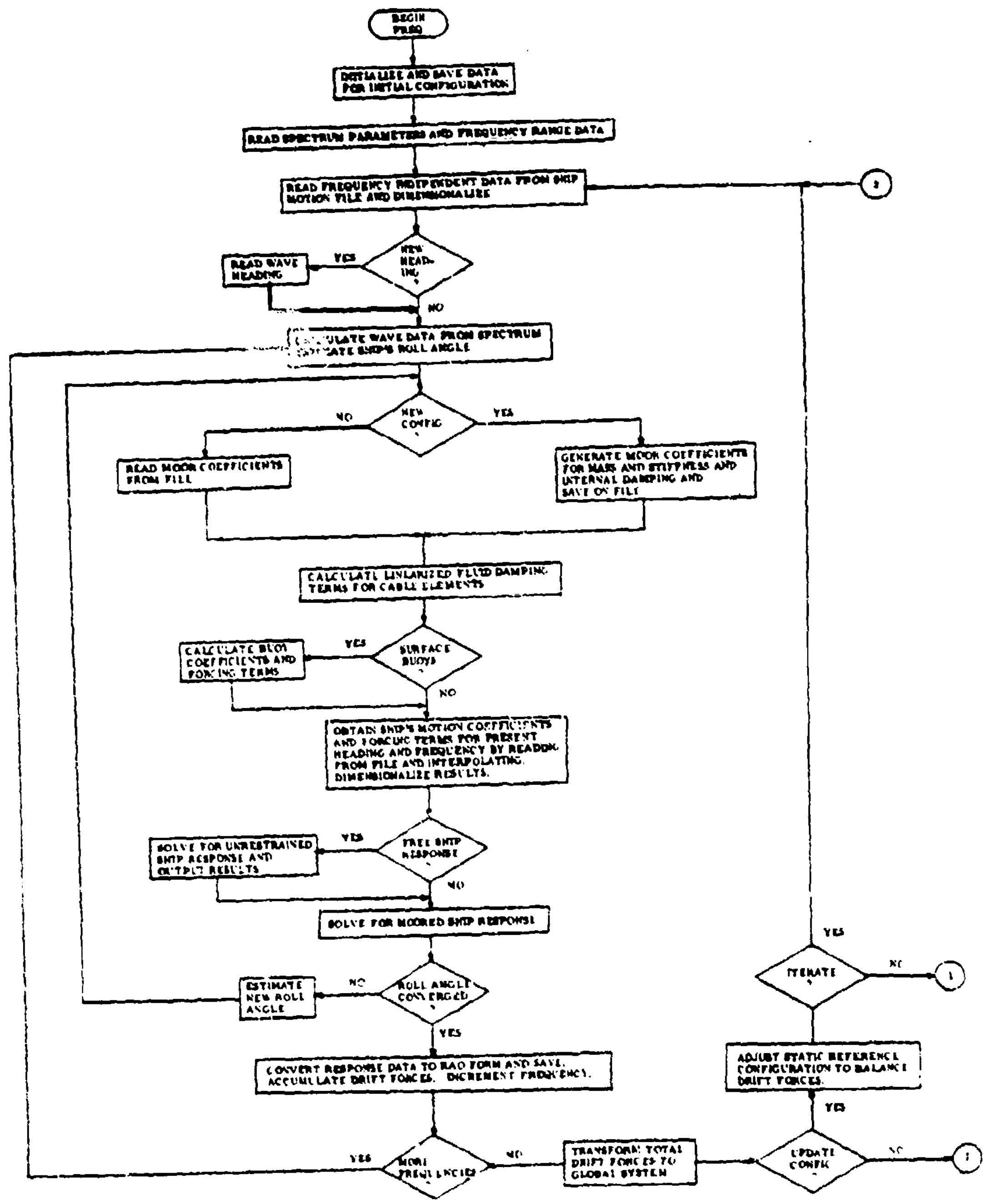


Figure 9-4. Frequency subanalysis.

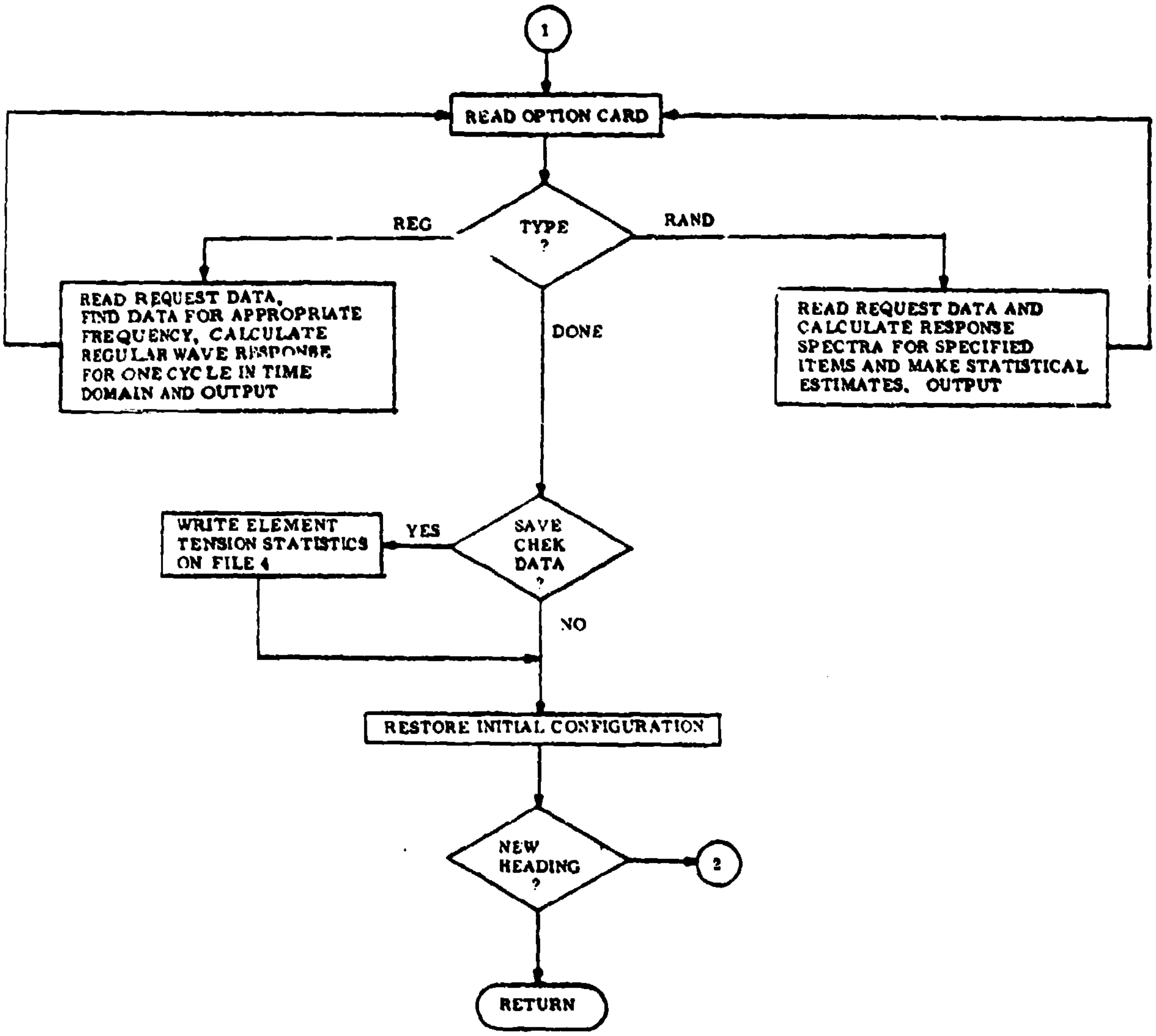


Figure 9-4. Continued.

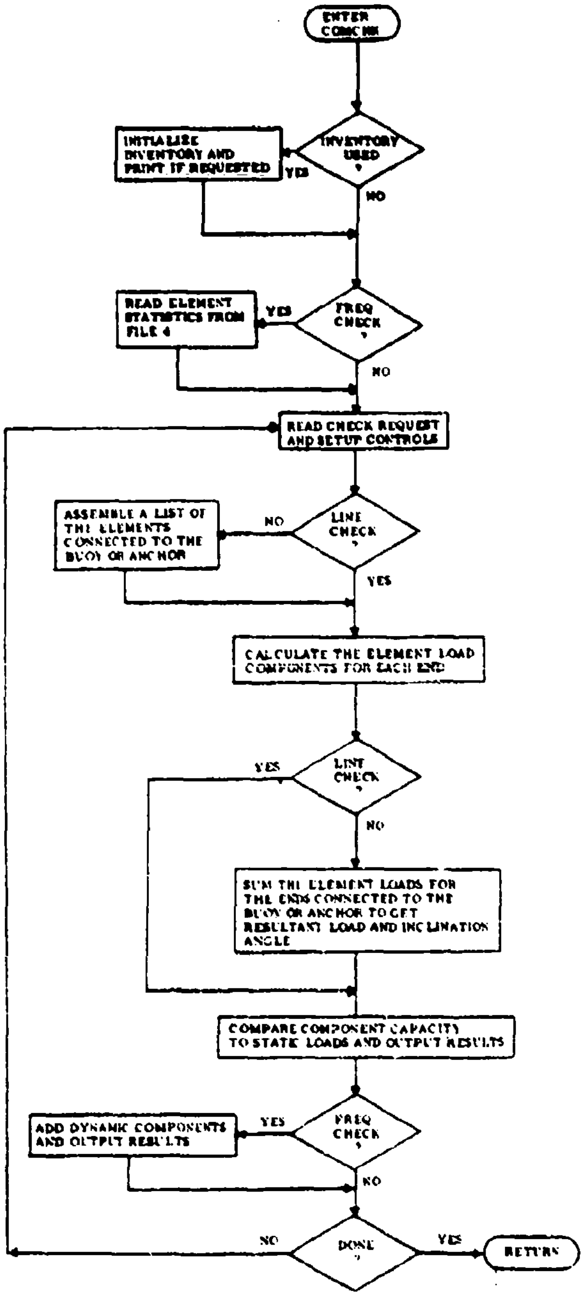


Figure 9-5. Check subanalysis.

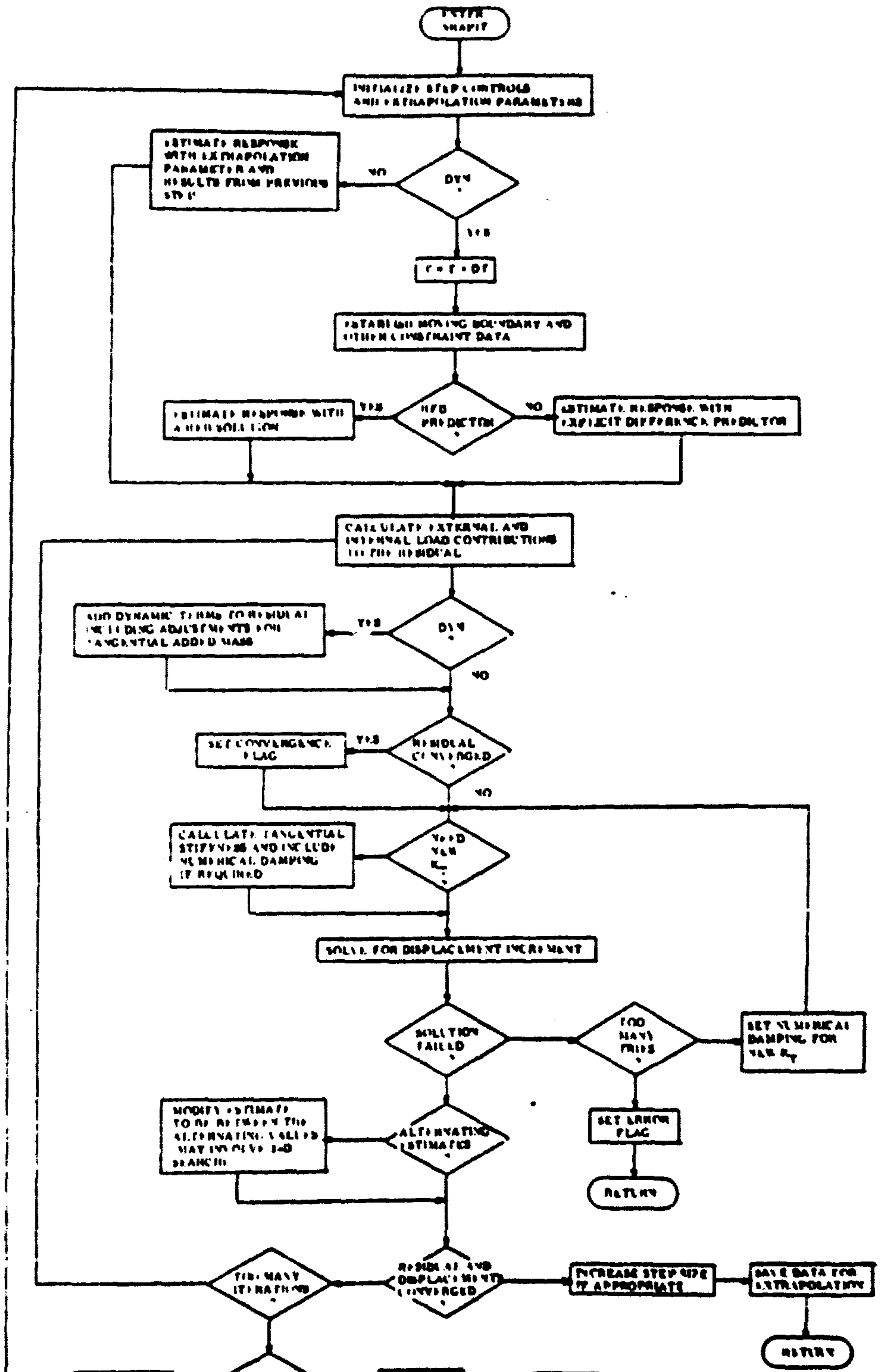


Figure 9-6. MNR logic.

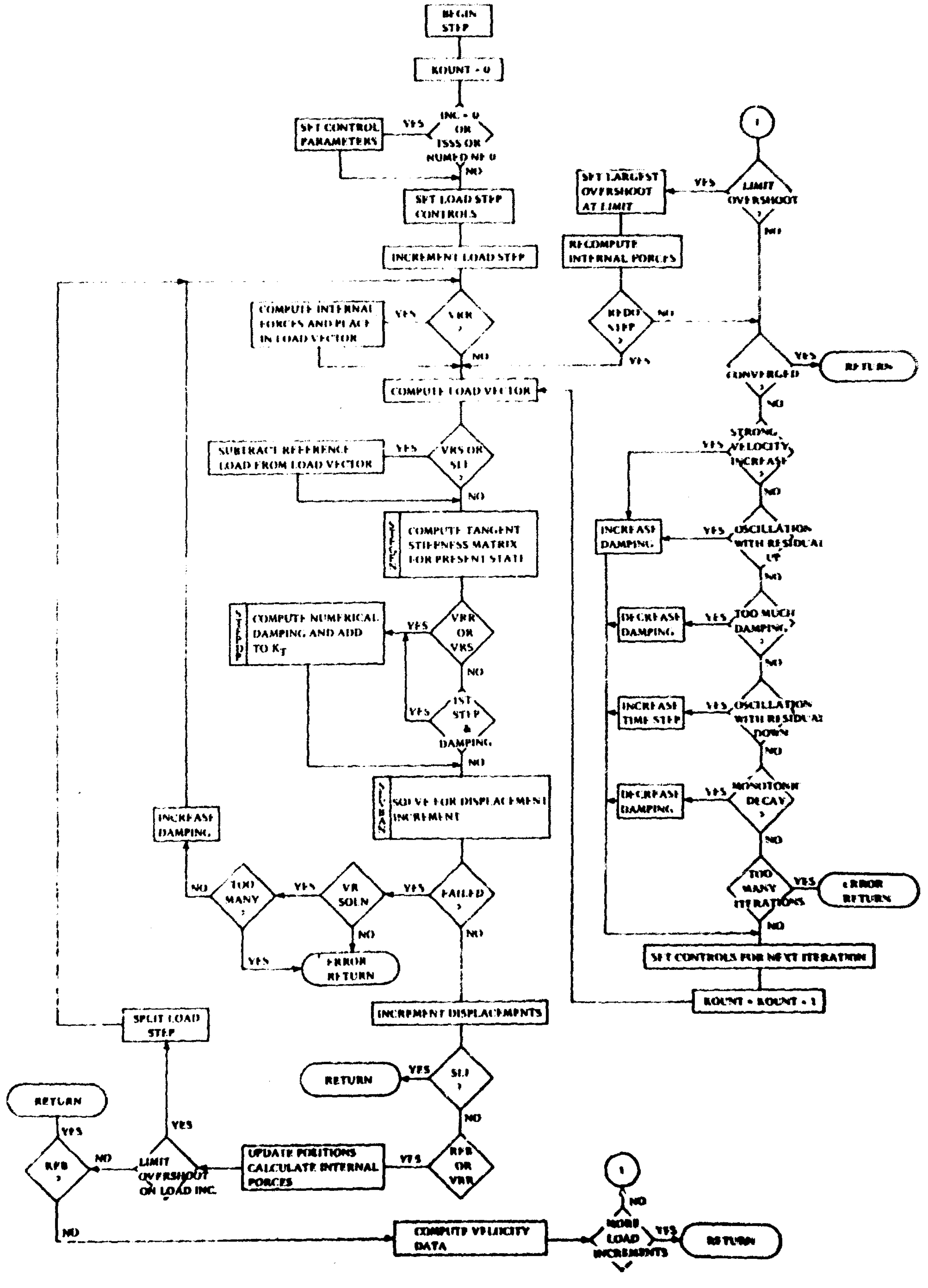


Figure 9.7 Step logic.

10.0 REFERENCES

10.1 Naval Civil Engineering Laboratory. Contract Report CR 82.019: SEADYN mathematical models, by R. L. Webster, Consulting Engineer. Brigham City, Utah, Apr 1982. (Contract No. N62474-81-C-9391)

10.2 ________________. Technical Note N-1630: SEADYN user's manual, by R. L. Webster and P. A. Palo. Port Hueneme, Calif., Apr 1982.

10.3 Leonard, J. W. "Curved finite element approximation to nonlinear cables," Paper OTC 1533, Fourth Annual Offshore Technology Conference, Houston, Tex, May 1972.

10.4 Dunder, V.F., and F. J. Robl. "NLIN: Nonlinear static and dynamic analysis of submerged cable structures,: Bechtel Corp., San Francisco, Calif., Nov 1973.

10.5 Naval Civil Engineering Laboratory. Contract Report CR 82.016: SEAPLT: A graphics post-processor for the SEADYN program, by R. L. Webster, Consulting Engineer. Brigham City, Utah, Apr 1982. (Contract No. 62474-81-C-9391)